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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

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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 [3]. 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. [3] 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 $9^0 30'$- $11^0 30'$ latitude and $34^0 20'$- $36^0 30'$ longitude. Plain undulating slopes and mountains characterize the topography of the region. The altitude of the region ranges mainly between 580 and 2731 meters

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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 Kebele*s* 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

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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.

Assosa district			Mao-Komo special district		
Kebele	**Number**	**Percent**	**Kebele**	**Number**	**Percents**
Belmele	13	5.22	Shoshor butuji	26	10.44
Megelle_37	33	13.25	Teja jalisi	36	14.46
Selga_19	23	9.24	Wetse wedessa	17	6.83
Selga_22	31	12.45			
Selga_23	41	16.47			
Selga_24	29	11.65			
Total	**170**	**68.27**		**79**	**31.73**

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.

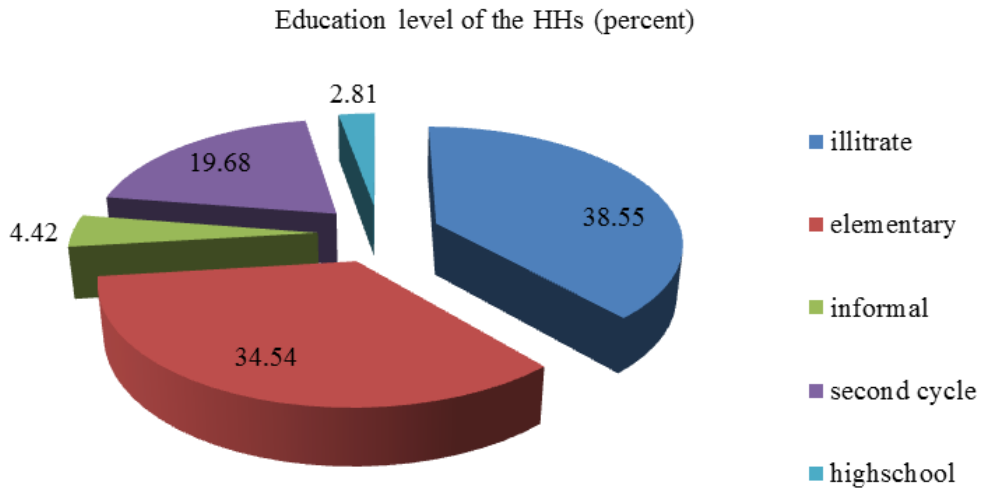

Figure-1. Education level of the respondents.

Source: Survey results, 2015/6.

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.

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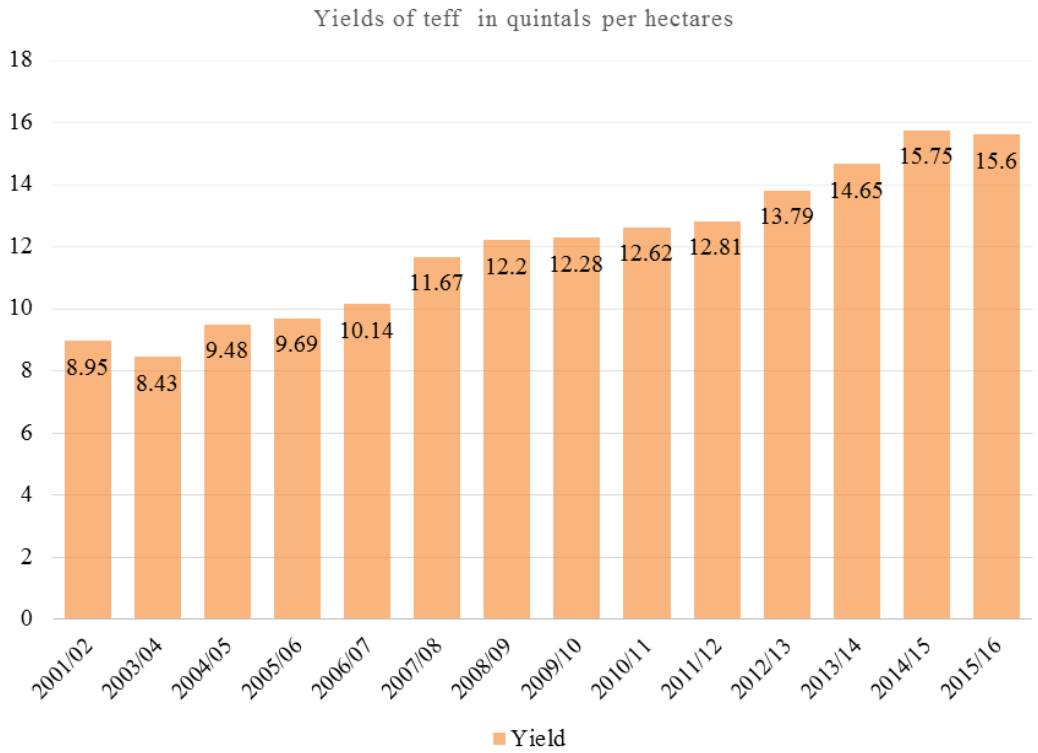

Figure-2. *Teff* productivity trends in Ethiopia.

Source: Taken from Cochrane [9].

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.

Table-2. Area under production and productivity of all crops cultivated in 2015/16 cropping season.

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	5.50	7.92	458.00
Haricot bean	33	13.25	0.25	2.30	3.31	1013.1
Faba bean	6	2.41	0.32	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

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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 indicates 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.

Table-3. Institutional and social networks of the households.

Characteristics	Adoption status				Total		$\chi 2$
	Non-adopters		Adopters				
	No	Yes	No	Yes	No	Yes	
Friend and families planted improved *Teff*	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	83	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	73	31	80	65	153	96	5.76**
Applied the recommended rate of fertilizer	93	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	13	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

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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 gov't/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.

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Table-6. Adoption of *Teff* improved varieties by districts.

Districts	Adoption status			
	Yes		No	
	N	%	N	%
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 *Tsedey* 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-adoption and stopping Adoption of improved *Teff* varieties.

No.	Reasons for non-adoption	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 susceptibility	1	1.85
5	Low grain yield	1	1.85
7	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.

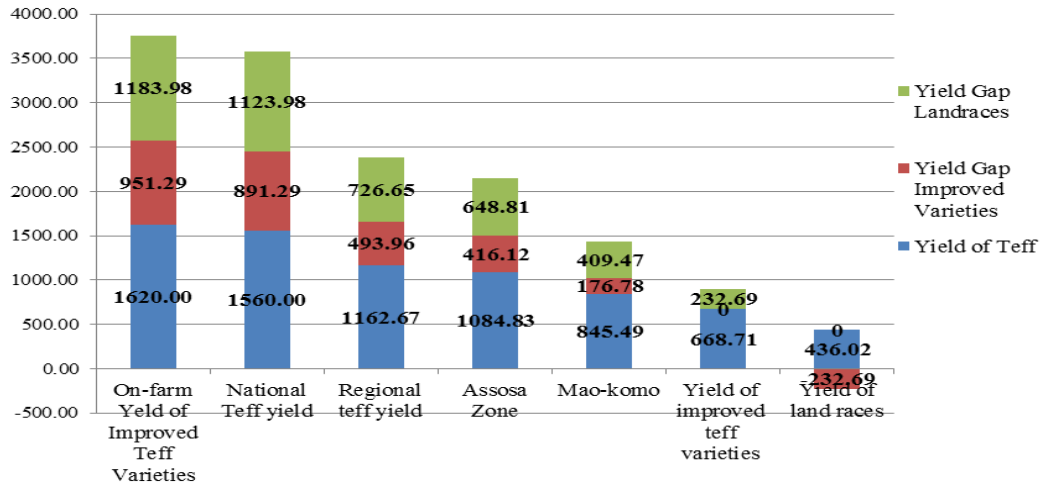

Figure-3. Productivity of *Teff* at national, regional, zonal, on-farm and households' level during 2015/16 cropping season.

Source: Survey results, 2015/16.

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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

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al. [11]; Feder and Umali [12]. 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 3times. 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 34.21kg 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 (N_2) (in kg) used	15.01	20.92	18.45	-5.91	-1.5*
Total DAP (N_2PO_5) 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.

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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

Appendix-1. Conversion factor used to compute Man- Equivalent (labor force).

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].

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Appendix-2. Teff Varietal attributes and preferences of households.

Description	Score based on importance										Total	Within index	Overall index	Over all rank
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10				
Grain color of Quncho	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 Quncho 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 Quncho	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 Quncho	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 Quncho	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 Quncho	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 Quncho	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 Quncho	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 Quncho	710	333	152	70	60	20	20	9	2	9	1385	0.600	0.027	9
Early maturity of Landrace	240	234	168	77	102	35	24	30	2	10	922	0.399	0.018	36
Grain size of Quncho	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 Quncho variety	600	297	264	49	102	15	36	3	0	9	1375	0.594	0.027	11

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Grain yield stability of Land races	320	117	192	77	120	60	48	3	2	1	940	0.406	0.019	28
Straw yield of Quncho	490	279	296	119	90	10	40	15	0	9	1348	0.581	0.027	12
Straw yield of landraces	360	108	112	168	156	30	28	3	2	5	972	0.419	0.019	24
Straw palatability of Quncho	630	198	240	112	102	35	8	12	4	9	1350	0.584	0.027	13
Straw palatability of landraces	320	153	144	119	156	25	20	15	2	6	960	0.416	0.019	25
Other foods making quality of Quncho	750	189	224	56	42	25	20	6	2	12	1326	0.608	0.026	14
Other food making quality of landraces	150	162	232	126	96	50	24	6	0	9	855	0.39	0.017	41
Storability of Quncho	880	180	136	28	30	0	40	0	8	21	1323	0.555	0.026	15
Storability of landraces	690	171	48	35	42	15	48	0	0	11	1060	0.445	0.021	22
Insect tolerance of Quncho	410	306	272	119	78	80	24	9	6	6	1310	0.584	0.026	16
Insects tolerance of Landraces	230	180	208	91	102	80	24	9	4	6	934	0.416	0.018	32
Shattering tolerance of Quncho	470	198	256	98	90	70	40	39	0	5	1266	0.572	0.025	17
Shattering Tolerance of Landraces	380	81	144	77	126	100	32	0	4	5	949	0.428	0.019	27
Disease tolerance of Quncho	430	216	240	168	102	30	40	27	2	9	1264	0.578	0.025	18
Disease tolerance of local	220	180	184	84	138	70	20	21	0	6	923	0.422	0.018	36
Drought tolerance of Quncho variety	470	198	176	98	108	50	64	12	4	18	1198	0.579	0.024	19
Drought tolerance of landraces	250	162	160	91	96	55	24	9	4	17	868	0.420	0.017	40
Less demand to inputs Quncho	470	153	176	56	108	35	92	27	2	10	1129	0.556	0.022	20
Less demand to inputs landraces	240	153	112	119	156	45	52	18	2	6	903	0.444	0.018	38
Water Lodging tolerance of Quncho	370	162	264	91	66	60	32	30	10	20	1105	0.603	0.022	21
Water lodging	240	135	96	49	78	65	36	12	0	17	728	0.397	0.014	43

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tolerance of landraces														
Frost tolerance of Quncho	370	144	200	77	72	40	56	21	6	30	1016	0.598	0.020	22
Frost tolerance of landraces	220	108	112	49	96	30	36	9	2	20	682	0.402	0.014	44
Overall rank of Quncho	810	324	208	49	60	10	8	6	0	0	1475	0.631		1
Overall rank of landraces	80	225	120	119	246	60	12	0	0	2	864	0.369		2
	Total score										50652			

Source: Survey results, 2015/16

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