Asian Journal of Research and Review in Agriculture

Volume 6, Issue 1, Page 371-379, 2024; Article no.AJRRA.1674

Large Scale Demonstration of Improved Tef [*Eragrostis Tef* (Zucc.) Trotter] Variety Bosset for Moisture Stressed Areas of Naedier-Adiet and Tahtay-Maichew Districts of Northern Ethiopia

Berhe Abraha [a*] and Haftamu Hailekiros [a]

[a] Tigray Agricultural Research Institute, Axum Agricultural research Center, Axum, Ethiopia.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.globalpresshub.com/review-history/1674

Original Research Article

Received: 14/07/2024
Accepted: 19/09/2024
Published: 23/09/2024

ABSTRACT

Tef is a stable food for majority Ethiopians constrained by moisture stress, insect and diseases contributed for low productivity of the crop. In Ethiopia, cluster farming is recently introduced as an extension approach to boost productivity and improve seed production system. The study was carried out with the objective to demonstrate and evaluate the performance and analyze the perception of farmers' on the improved early maturing tef variety with integrated management practice at a large scale through cluster approach in two moisture stressed areas of Naedier Adiet

**Corresponding author: E-mail: berhegered@gmail.com;*

Cite as: *Abraha, Berhe, and Haftamu Hailekiros. 2024. "Large Scale Demonstration of Improved Tef [Eragrostis Tef (Zucc.) Trotter] Variety Bosset for Moisture Stressed Areas of Naedier-Adiet and Tahtay-Maichew Districts of Northern Ethiopia". Asian Journal of Research and Review in Agriculture 6 (1):371-79. https://jagriculture.com/index.php/AJRRA/article/view/112.*

and Tahitay Maychew districts. A total of 172 interested farmers were selected purposely and each allocated an average area of 0.25 hectare. Data was collected from farmers using quadrant tool sampling method to evaluate yield performance and analyzed using descriptive statistical of mean, standard deviation and Likert scale measurements was used for perception of farmers. An average yield of 1307.59 kg ha-1 was obtained which has a yield advantage over the traditional way tef production. The pre and post harvest perception data also showed the acceptance of the variety based on yield attributes such as earliness to mature, higher yield, tolerance to moisture stress, taste of food and "Injera" quality. Therefore, the variety should be further promoted to large number of farmers under wider cluster areas of similar agro-ecologies.

Keywords: Bosset; large scale demonstration; moisture stress; tef; yield.

1. INTRODUCTION

Agriculture is the backbone of the Ethiopian economy. The most national gross domestic product (GDP) of the country is traced from the agriculture sector [1,2]. It is dominated by smallholder farmers who occupy the majority of land and produce crop and livestock products. Similarly, crop production is the major contributor of GDP that accounts for approximately 30% of the sub-sector of agriculture [3].

Tef [*Eragrostis tef* (Zucc.) Trotter], its center of origin and diversity is in Ethiopia [4,5]. Tef is an important staple cereal crop in Ethiopia occupying more than 2.9 million hectare of land. It is first in area coverage but second and last in production and productivity respectively, from cereals under production in Ethiopia. It is grown by over 7.5 million households, and constitutes the major staple food grain for over 70 million Ethiopians [6].

Internationally little researches has been done in tef as compared to rice, maize, wheat and sorghum this often called an "orphan" crop [7]. Tef is best grown at an altitude between 1800 to 2200 meter above sea level [8], but has a broad range of adaptation from below sea level up to 3000 m.a.s.l. [5]. Tef is like no other cereals, it is a C_4 plant along with sorghum and maize, it is hardy and able to withstand adverse climatic conditions and consequently considered as lower risk crop compared to other cereals like wheat, barley and maize [9]. Tef is economically and nutritionally important crop: for farm income, food and nutritional security in Ethiopia. The grain used for making Injera, a spongy flatbread which is the leading food crop in their consumption basket for consumers. Tef has remarkable useful genetic and agronomic traits; reasonable tolerance to both drought and water logging, moisture stress, adapted to varied agro-ecological and edaphic conditions as well as adaptable to various cropping system, crop rotation schemes, relative resilience of epidemic disease, pest and minimal post-harvest loses [10]. Similarly, among cereals it has important advantages such as protein, calcium, phosphorus, Iron, copper, barium, thiamine and balanced amino acid [5]. Tef is also considered to be a healthy food due to its grain is free of gluten [11,12]. Tef has also high iron content that makes it appropriate for pregnancy-related anemia; at least, in its major production belts [13,14]. This implies that tef is very important crop in the overall food and nutritional security of the country [15].

Even though tef has numerous merits and considerable economic significance in Ethiopia, the national average grain yield of tef is relatively low which is1.8 tone ha^{-1} as compared to its estimated potential 6 tone ha^{-1} [16,17]. However, Berheet al [18] reported that tef yields 4000 kg ha-1 and 2500 kg ha-1 on research and farmers' fields, respectively. Although it has the highest importance the country does not give the higher investment on the development of the crop.

Despite its greater economic value and coverage of large area, the productivity of tef is relatively low in the country mainly due to the low yielding ability of unimproved local cultivars, lodging, erratic rain fail and other biotic and abiotic factors [19-22]. Nationally, many research institutions are dueling on the development of tef variety for optimum and moisture stressed areas and achieved some results. Adaptive to moisture stress and high yielding Bosset variety is among the achieved results, and introduced from Debrezit Agricultural Research Center to Axum Agricultural research Center mandate areas through adaptation trial, after years of adaptation trial Bosset variety was recommended as better variety for moisture stressed areas. Therefore, this study was carried out with an attempt to

demonstrate and evaluate the performance and analyze the perception of farmers' on the improved early maturing tef variety at a large scale in different moisture stressed areas.

2. MATERIALS AND METHODS

2.1 Description of the Study Areas

The study was carried out in two districts of central Zone of Tigray regional state, Northern Ethiopia. One peasant association (PA) was selected from each district. Tahtay Maychew district is situated in a geographic location of $38^0$32' and $14^0$07'E, and $13^0$15' and $14^0$39'N and altitude of 1500-2260 meter above sea level (m.a.s.l.) whereas Naedier Adiet district is located at 38°38' 19" E longitude and 13 °52' 16''N altitude of 2122 m.a.s.l. the districts received a mono modal annual rainfall of Tahtay Maychew and Naedier Adiet 500-700mm and 850.5mm (during summer) with a 20^0c and 25^0c, respectively according to the office of Agriculture and Rural Development (OoARD) of the respective districts (2006). The study areas have a good climatic condition and compatible for growing Tef. The agro-ecology of Tahtay Maychew is tepid to cool sub moist mid highlands SM_2 5D-2, 70% mid-land ''Weina-dega'' and hot to warm sub moist lowlands or SM14D 30% ''Kola'' (AxARC, 2004). Similarly, Naedier Adiet ranges Weina-dega to intermediate low land with a temperature ranges of 12.5^0c to 28.9^0c (Fig.1).

2.2 Selection of Beneficiaries and Field Activities

Naedier adiet and Tahitay maichew; Abebayehans and Wuhdet Peasant Associations (PA), respectively, were selected purposively based on their representative for most moisture stressed areas and poor soil fertility relatively against the other areas in central Zone of Tigray. A total of 172 beneficiary farmers were selected based on interest for tef production, gender consideration, having adjacent farm land and poor or disadvantaged households but can work and believed to improve their livelihood in both PAs. Each farmer allocated 0.25 ha of land. Sowing was done by broad casting at a seed rate 15 kg ha^{-1} recommended rate. Chemical fertilizers, 100 kg DAP and 100 kg Urea was used. All recommended rate of NPSB and one half of urea was applied at planting and the remaining amount of urea was applied just after second weeding (35-40 days after planting). The other agronomic practices were applied as per the recommendation for the crop.

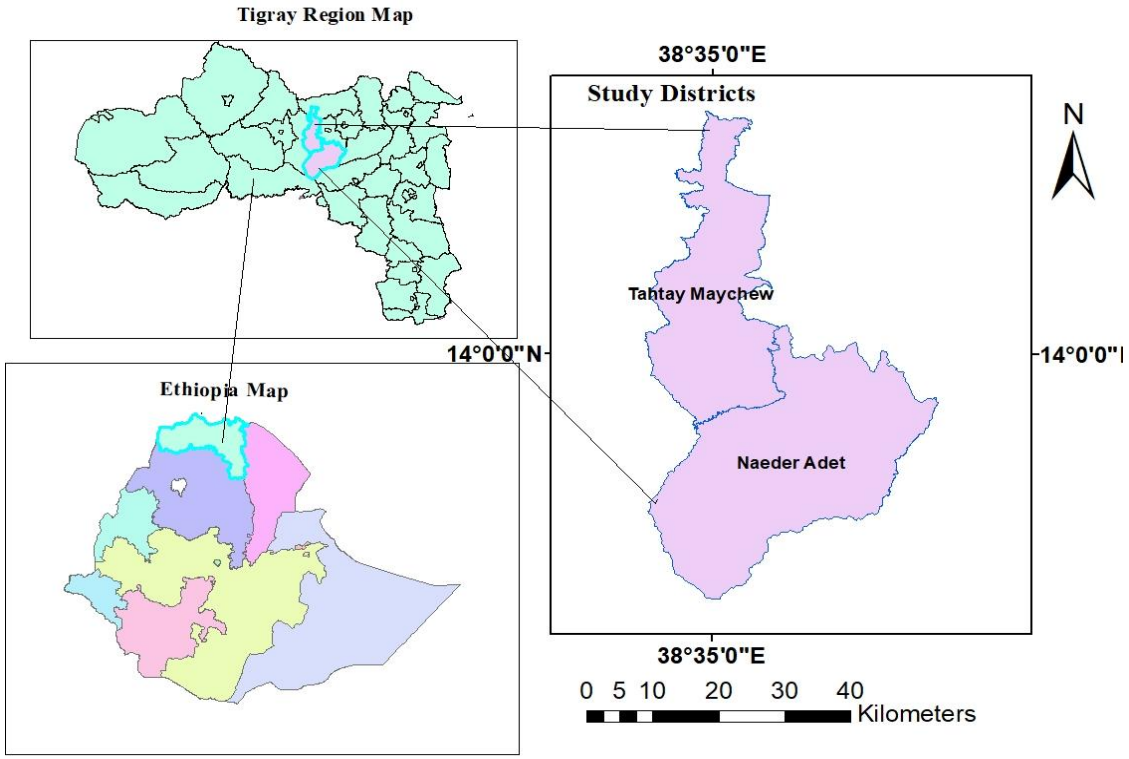

Fig. 1. Location Map of the study areas

2.3 Capacity Building Provision

Capacity building was provided for the participant farmers (Table 1), Woreda experts, development agents administrative bodies about how to manage the large scale demonstration of improved variety and production packages of like agronomic practices and how to implement the technologies on farmers' field. In addition, field day and field visits were organized in the districts to evaluate the demonstrations.

2.4 Field Day and Visit

In recent years, participatory research has become increasingly relevant in public agricultural research. The degree to which a technology dissemination process is participatory and ensures the participation of all stakeholders, especially the poorest members of society, are frequently used to assess its effectiveness [23] The basic planning tasks, performing on-farm trials, and evaluating the planning and trials are all focused on "learning by doing and sharing experience," with researchers, extension staff, and farmers participating. As a result, the aim of participating farmers and other actors in the research system is to optimize yield while also improving actors' participation in selecting technologies that meet their preferences for long-term technology diffusion. Therefore, an experience sharing was organized in both districts 325 participants; (Table 2) beneficiary and non-beneficiary farmers, experts, zonal economic advisories and concerned administrative bodies were participated. The beneficiary farmers showed their interest to continue the use of the technologies on a larger acre of land and as business as a seed producer. The non-beneficiary farmers of the cluster were also convinced to adopt the technology and farming practices.

Table 1. Number of participants by sex during the training

Location	Farmers			Development Agents			Experts and others		
	M	F	T	M	F	T	M	F	T
T/maichew (Wuhdet)	93	17	110	3	1	4	4	0	4
N/adiet (Abebayehans)	55	7	62	1	1	2	2	0	2

Note: M = Male, F = Female and T = Total

Fig. 2. participants during the field day at Naeder Adiet district

Table 2. Number of participants during the field day

Participants	Male	Female	Total	Location
Farmers	50	12	62	T/maichew
	50	25	75	Naedier Adiet
Development Agents	15	6	21	T/maichew
	13	3	16	Naedier Adiet
Experts and others	35	20	55	T/maichew
	25	5	30	Naedier Adiet
Researchers	27	6	33	T/maichew
	25	8	33	Naedier Adiet
Grand Total	**240**	**85**	**325**	

2.5 Data Collection

During the demonstration period both qualitative and quantitative data types were collected from primary sources. Among the total 172 participant farmers in the large scale demonstration of Bosset variety 26 sample respondents were selected (13 from Naeder Adiet district and 13 from Tahtay Maichew district), from which both yield and perception data were collected. Perception of participant farmers was collected both at harvest and at pre-harvest stages. In this case, during simple random sampling technique was employed to select sample respondents to collect the data from which the scientific information was generated. Quantitative data related to harvested yield harvested was collected during harvesting time. During data collection quadrant method and personal interview were employed. Quadrant Method was employed to collect yield data in particular so that trustworthiness of the data collected from the respondents through interview was insured. Quantitative data related to perception of the participant farmers was collected using personal interview both at harvesting time and at an earlier growth stage of tef.

2.6 Data Analysis

The collected data was subjected to the SPSS v.20 software version to analyze the data. The data was analyzed using descriptive statistics like percentage, mean, frequency and statistical test was employed and for the perception data 1-5 Likert scale measurement was used.

3. RESULTS AND DISCUSSION

3.1 Grain Yield Performance

The descriptive statistics result in (Table 3) indicated that there was statistically significant yield difference for the variety across the respective districts (t= -3.56 and p= 0.02). The mean yield of bosset at Naeder Adiet and Tahtay-Maychew was 1485.09 kg ha^{-1} and 1157.39 kg ha^{-1} respectively, which is higher over the traditional way of tef production which is 8002 kg ha^{-1} (AxARC). This difference might be attributed integrated agronomic management practices and agronomic parameters such as good plant stand, earliness to mature, tolerance to disease and pests resulted by availability of moisture. The result coincides with the findings of Yared et al. [24] who reported that bosset and local gave a yield of 1001 kg ha^{-1} and 840 kg ha^{-1} respectively, with the yield advantage of 19.2% in different moisture stressed areas. Other evidences also reported by Kebede et al. [25] improved and land races tef varieties using different planting method in semi-arid climatic areas of Northern Ethiopia showed significant yield difference. In contrary with this study, as reported by Hadgu et al. [26] the bosset variety tested in different moisture stressed areas of Ethiopia recorded higher yield 2592 kg ha^{-1} this could be due to integrated and improved agronomic management practice and soil fertility of tested locations [27,28].

Table 3. Average grain yield (kg/ha) of bosset variety at Naedier Adiet and Tahtay-Maichew districts during 2019/20

Yield component	N	Min	Max	Mean	SD	t-value	Value
N/adiet (Abebayehans)	13	1177.5	1967.00	1485.09	303.96	-3.56	0.02
T/maichew (Wuhdet)	11	1052.7	1555.00	1157.397	321.13		
Average yield				1307.59			

Table 4. Farmers perception towards pre- and post-harvest attributes of the Tef 'bosset'

Attributes	N	Perception level of respondents (n= 26)					Mean	Sd
		St. agree	Agree	No change	Dis-agree	St.dis-Agree		
Earliness to mature	26	7(23.1)	17 (65.4)	3 (11.5)	0	0	4.12	0.59
Tolerance to disease (rust)	26	0	12(46.2)	9 (34.6)	5(19.2)	0	3.27	0.78
Reaction to shot fly	26		1(3.8)	25(96.2)		0	3.04	1.9
Tolerance moisture stress	26	519.2	16(61.5)	4(15.3)	1(3.8)	0	3.96	0.72
Grain yield	26	12(46.2)	11(42.3)	3 (11.5)	0	0	4.35	0.69
Seed color	26	0	23 (88.5)	0	3(11.5)	0	3.77	0.65
Market demand	26	6(23.1)	14 (53.8)	4(15.4)	2 (7.7)	0	3.92	0.84
'Injera' quality	26		14(73.1)	3(11.5)	0	0	4.04	0.53
Mean weight							3.8	

Note: SA= Strongly Agree (5), A= Agree (4), NC= No change (3), DA= Dis agree (2) and SD= strongly disagree (1)

3.2 Farmers' Perception towards the Variety

As shown in (Table 4) farmers showed positive perception on pre-harvest and post-harvest features of the variety. Most respondents were respond positively on the attributes in terms earliness to mature, tolerance to disease, reaction shoot fly, grain yield, seed color and "injera" quality, seed uniformity, easiness for threshing, tolerance to moisture stress and market preference by consumers.

4. CONCLUSION AND RECOMMENDA-TIONS

According to grain yield performance and farmers perception, Bosset variety showed better mean grain yield performance in both tested districts. Farmers also identified grain yield, seed uniformity, seed colour, easiness to thresh, earliness to mature, injera quality, tolerance moisture stress tolerance to disease and insect pests, and market preference by consumers as the best selection criteria of Bosset. Finally, the variety was found to be promising in most of the attributed considered. It has also get good acceptance to further multiply and disseminate seeds to other tef producing moisture stressed areas. Therefore, bureau of agriculture and other local and international developmental organizations would also better devote their effort to promote the variety at a wider scale to similar agro ecologies. In addition, it is also important to work with seed producing cooperatives, unions and seed enterprises for sustainable supply and availability of quality seed production. Besides, it helps in providing economic and nutritional security for poor farming community in the rural areas.It is also important for embracing policymakers' insight and attitude, which in turn national and regional agricultural strategies and policies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENTS

The authors acknowledges Tigray Agricultural Research Institute, Axum Agricultural Research Center for providing the required budget to conduct the experiment. We would also like to acknowledge the crop core process researchers for their dedicated work in data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Driba Getachew. Agricultural and rural transformation in Ethiopia. Ethiopian Journal of Economics. 2020;27(2):51 -11.
2. Duguma LA, Wambugu SW, Minang PA, Van Noordwijk M. A systematic analysis of enabling conditions for synergy between climate change mitigation and adaptation measures in developing countries. Environmental Science & Policy. 2014;42: 138-148.
3. Central statistical Authority. Agricultural sample survey. Report on area and production of major crops. Addis Ababa: Central Statistical Agency; 2017/2018.
4. Vavilov NI. The origin, variation, immunity and breeding of cultivated plants, Chronica Botanica. 1951:13:1-366.
5. Ethiopian Institute Agricultural Research (EIAR). Pulse Research Strategy, 2016-2032.Ethiopian Agricultural Transformation Agency; 2017.
Available:http://www.eiar.gov.et. Ethiopia
6. CSA (Central Statistical Agency). Agricultural Sample Survey. Statistical Bulletin, Addis Ababa, Ethiopia: Central Statistical Agency. 2021;4.
7. Girija, A, Jifar H, Jones C, Yadav R, Doonan J, Mur LAJ. Tef a tiny grain with enormous potential. Trends in plant Science. 2022;27(3):220-223.
8. Minten B, Alemayehu Seyoum A, Petra P.The Economics of Teff: Exploring Ethiopia's Biggest Cash Crop for Two Main Reasons; 2018.
9. Fufa B, Behute B, Simons R, Berhe T. Strengthening the tef value chain in Ethiopia. Mimeo, Agricultural Transformation Agency (ATA), Addis Ababa; 2011.
10. Assefa K, Cannarozzi G, Girma D, Kamies R, Chanyalew S, Plaza-Wüthrich S, Blösch R, Rindisbacher A, Rafudeen S, Tadele Z. Genetic diversity in Tef [*Eragrostis Tef*

(Zucc.) Trotter]. Frontiers in Plant Science. 2015;6:177.

11. Spaenij-Dekking L, Yvonne KW, Frits K. The Ethiopian cereal Tef in celiac disease. TheNewEngland Journal of Medicine. 2005;353:1748–1749.
12. Saturni L, Ferretti G, Bacchetti T. The gluten-free diet: safety and nutritional quality. Nutrients. 2010;2(1):16-34
13. Alaunyte, I, Stojceska V, Plunkett A, Ainsworth P, Derbyshire E. Improving the quality of nutrient-rich Tef (Eragrostis Tef) breads by combination of enzymes in straight dough and sourdough bread making, Journal of Cereal Science. 2012; 55:22-30.
14. Assefa K, Belay G, Tefera H, Yu JK, and Sorrells ME. Breeding Tef: conventional and molecular approaches. pp 21-25. In: Zerihun Tadele (ed.) New Approaches to Plant Breeding of Orphan Crops in Africa: Proceedings of an International Conference. 2009;19-21.
15. Assefa K, Solomon C, Zerihun T. Achievements and Prospects of Tef Improvement; Proceedings of the Second International Work shop, November 7- 9, 2011, DebreZeit, Ethiopia. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia; Institute of Plant Sciences, University of Bern, Switzerland. Printed at Stämpfli AG, 3001 Bern, Switzerland. (Eds) 2013. ISBN: 978-3-033 -03.
16. Ketema S. Tef (Eragrostis Tef): Breeding, agronomy, genetic resources, utilization, and role in Ethiopian Agriculture. Institute of Agricultural Research, Addis Abeba, Ethiopia; 1993.
17. MoA. *Crop variety register issue No. 21.* Ministry of Agriculture plant variety release, protection, and seed quality control directorate. Addis Ababa, Ethiopia; 2018.
18. Tareke Berhe, Zewdie Gebretsadik, Sue Edwards and Hailu Araya. Boosting Tef productivity Using Improved Agronomic Practices and Appropriate Fertilizer ..In: Zerihun Tadele (eds.) *Achievements and Prospects of Tef Improvement; Proceedings of the Second International Workshop,* Debre-Zeit, Ethiopia. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia; Institute of Plant Sciences, University of Bern, Switzerland. Printed at Stampfli AG, 3001 Bern, Switzerland. 2013;7-43.
19. Assefa K, Yu JK, Zeid M, Belay G, Tefera H, Sorrells MS. Breeding Tef [Eragrostis Tef (Zucc.) trotter]: conventional and molecular approaches, Plant Breeding. 2017;130:1-9.
20. Assefa K, Canyalew S, Tadele Z. Tef Eragrostis Tef (Zucc) Trotter, millets and Sorghum in Biology and genetic improvrment, J.V. Patil, ED, Jhon Wiley and Sons Ltd. Published by Jhon Wiley and Sons Ltd, First Edition; 2011.
21. ARARI. Amhara Agricultural Research Institute, Strategic document for the establishment of new agricultural research center in East Gojjam zone: Amhara Region agricultural research Institute; 2016.
22. Ferede S, Yirga C, Kehaliew A, Agegnehu G, and Alemu T. Farming systems characterization and analysis in East Gojjam Zone: implication for research and development (R&D) interventions. Ethiopian Institute of Agricultural Research; 2020.
23. Binswanger-Mkhize HP, Bourguignon C, Brink RVD. Agricultural Land Redistribution: Toward Greater Consensus. Agriculture and Rural Development.: © World Bank; 2009
Available:http://hdl.handle.net/10986/2653
License: CC BY 3.0 IGO.
24. Yared T, Obsa C, Seyoum A, Kabna A, Girma T. Participatory variety selection of improved tef varities for low moisture. International Research Journal of Natural Sciences. 2022;10(3): 49-55.
25. Worku Kebede YG. Tef (Eragrostis tef) variety development for moisture stress areas of Ethiopia. Journal of Innovative Agriculture. 2020;7(4): 1-6.
26. Hadgu G, Tesfaye K, Mamo G, Kasa B. Trend and variability of rainfall in Tigray, northern Ethiopia: Analysis of metrological data and farmers' perception. Academia Journal of Environmental. 2013;159-171.
27. Haileselassie B, Stomph T, Hoffland E. Teff [Eragrostis tef (Zucc.) Trotter] production constraints on vertisols in Ethiopia: Farmers' perceptions and evaluation of low soil zinc as yield limiting. Soil Science and Plant Nutrition. 2011; 587-596.

28. Mizan T, Hussein S, Mark L, Kebebew A. Achievements and gaps in Tef productivity improvement practices in the marginal areas of Northern Ethiopia: Implications for future research directions, International Journal of Agricultural Sustainability. 2016; 27.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.globalpresshub.com/review-history/1674