Yam Production Constraints, Farming Systems and Farmer Preferred Traits in Ethiopia: Implication for Breeding and Conservation

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Abstract

Yam production in Southwest Ethiopia is threatened by a socioeconomic, a biotic and biotic factors. The objective of this study was to document the major yam production constraints, farming systems, the number of farmers identified landraces and trait preferences from major growing areas of Southwest Ethiopia. A participatory rural appraisal study was conducted in seven yam producing districts of the region. Data were collected from 240 yam growers using a semi-structured questionnaire, focus group, key informant discussions and field observations. Yam production restraints were mainly associated with socioeconomic factors such as low attention given to the crop and dilution of the crop by improved crop technologies, which reported by 14.71 and 11.15% of respondents, respectively. Drought and wild animal attacks were the major cause of yield reduction, as reported by 14.4 and 13.93% of the respondents, respectively. A total of 38 farmers' named yam landraces was identified for their traits preferences. The major yam traits preferred by farmers were: high yield (35.42%), good market (11.05%), early maturity (8.86%), powdery after boil (10.48%) and disease resistance (3.53%). Medicinal use reported by 5.58% of respondents and white and mixture with red flesh color (5.91%) was the main farmer and market preferred traits. Yam variety development programs should therefore discourse the above constraints and farmer-preferred traits for sustainable yam production in Southwest Ethiopia.

Keywords: Farmers' landraces, participatory, preferences production, traits, yam

Introduction

Yam (*Dioscorea* spp.) is a multi-species crop that belongs to the genus *Dioscorea* and family *Dioscoreaceae* (Mignouna *et al.*, 2002; Dansi *et al.*, 2010). It is found in Africa, India, Southeast Asia, Australia and South America comprising of 600 species (Tewodros, 2013; Loko *et al.*, 2015). All species are tropical origin and cultivated for their edible starchy tubers (Paterne *et al.*, 2019). From all,

about ten yam species are cultivated for food staples serving millions of people in the tropics (Sesay *et al.*, 2013; Dansi *et al.*, 2010). West Africa is the predominant yam producing region globally (Coursey, 1967; Tamiru *et al.*, 2007). The region contributes 95% of the world's yam production with considerable varietal and genetic diversity of yams (Hamadina *et al.*, 2009; Dansi *et al.*, 2013). Although, yams are cultivated mainly in West Africa, the most important species are widely adopted in Ethiopia as cultivated and wild relatives (Terauchi *et al.*, 1992; Tamiru *et al.*, 2007; Dansi *et al.*, 2012). In Ethiopia,a large pool of yams that are widely distributed in complex cropping systems with wide genetic base in different parts of the country (Hildebrand, 2003; Wendawek *et al.*, 2013). It is the third most important root crop in Ethiopia, after cassava (*Manihot esculenta* Crantz) and sweet potato (*Ipomoea batatas* (L.) Poir) (Tamiru *et al.*, 2007). It widely cultivated in South, Southwest and Western parts of the country and over 1.5 million people depend on it (Tewodros, 2013). In addition to the food, the storage tuber of yams contains some pharmacologically active substances (dioscorine and sapogenin) and used as medicine for ailments related to the digestive tract and reduce the blood glucose level (Jaleel *et al.*, 2007; Nashriyah *et al.*, 2012; Tewodros *et al.*, 2018). Besides, the crop is also used as female contraceptive and has higher contribution to reduce the growing people currently facing (Scarcelli *et al.*, 2011).

The most important feature of yam is good adaptability and produce high yields in broad agro ecology (Nora *et al.*, 2006), annual cycle of food availability, diverse maturity and flexibility harvest periods without the use of large amounts of agricultural inputs (Tamiru *et al.*, 2008; Mauricio *et al.*, 2014). However, yam production in Ethiopia faces various constraints, amongst which, low yields, socioeconomic factors, lack of adapted varieties for diverse agro-ecologies and presence of biotic and a biotic stress that are threatening its production and productivity (Robert *et al.*, 2010; Happy *et al.*, 2018). Use of improved varieties with suitable agronomic practices is essential to boost yam production in the region. Further, in-depth knowledge of farmers' preferences, production challenges, and priorities are prerequisites in production and technology development (Happy *et al.*, 2018). Previous studies conducted by Tamiru *et al.*, (2011) identified drought and shortage of planting materials as the main yam production problems in Southern Ethiopia. However, the report did not fully cover the major yam growing areas of southwest Ethiopia. Thus, comprehensive assessment on production problems and farmers preferred traits present in Ethiopian yam germplasm is required to use a relatively greater number of samples from the diverse growing regions for

documentation and sustainable yam production in Southwest Ethiopia.

Participatory Rural Appraisal (PRA) is an interdisciplinary research approach useful to capture yam production constraints and farmers preferences (Happy *et al.,* 2018). For instance, participatory breeding incorporates farmers' knowledges and preferences during variety development, testing, and release (Tamiru *et al.,* 2011). This leads to increased adoption of newly developed cultivars by farmers (Dorward *et al.,* 2007). Therefore, it is important to consider farmers' needs and preferences in the yam variety development, to improve production, selection to ensure adoption of improved cultivars by farmers and to address the existed problems in an affordable and sustainable way. Hence, the objective of this study was to identify the major constraints affecting yam production and farmer-preferred yam traits in Southwest Ethiopia for future breeding programs.

Materials and Methods

Description of study areas

The study was conducted in Jimma, Sheka and Bench-maji zones, which are the major yam production areas of Ethiopia from October, 2013 to June, 2013. Accordingly, five districts namely, Manna, Dedo, Shebe-sombo, Seka-chekorsa and Kersa from Jimma zone and two districts namely Sheko and Yeki from Bench-maji and Sheka zones, respectively, were selected (Figure 1). These areas were selected for study based on strong traditions in cultivating and domesticating various yam landraces with wide genetic base (Hildebrand, 2003), high production potential and the long history of production and management system of yam with farmers' traditional knowledge (Tamiru *et al.,* 2008).

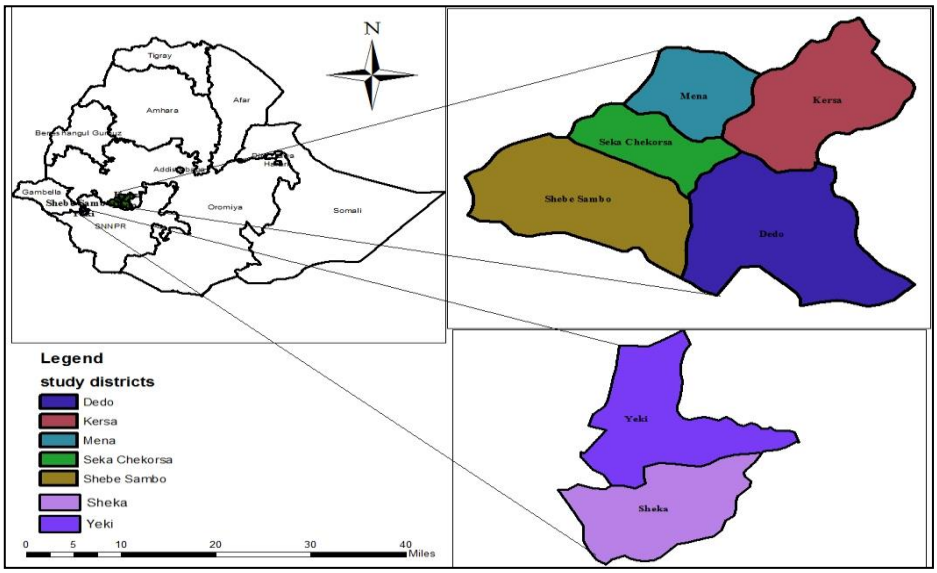

Figure 1. Administrative map of Ethiopia showing seven districts where the survey data were collected. Source Tewodros *et.al,* (2018).

Questionnaire design, sampling and data collection

For this study, stratified random sampling procedure was followed to describe the sampling units. The area was stratified first based on elevation and agroecology to wrap appropriate ecological range of yam and kebeles (small administration unit in Ethiopia) were elected and judge as main yam growing areas. A semi-structured questionnaire, transect walks and field visits (home gardens, cultivated fields) key informants and focus group discussions were used to collect information from selected farmers. Data gathered from transect walks, field visits and key informants were used to provision and confirm the information obtained from the semi-structured questionnaire. From each district on average 34 farmers, 15-20 yam producers, 10 key informants and five development agents (DA's) were sampled from different social groups for individual interviews, group and key informants' discussions. In total, 240 farmers were interviewed using the semi-structured questionnaire and key informant discussions. Through the semi-structured questionnaire, the following data were gathered: household information, farm size, farming system used, number of landraces in each district, constraints in yam production, important crop traits preferred by farmers and market accessibility. Transect walk was also done to make direct observations on a few randomly selected fields in each village in each district. Other PRA tools used to gather information included the number of farmers' identified yam landraces grown and major production problems in all districts. In addition, farmers were asked about the type of yams, trait

preferences and utilization options were described and ranked using a 1-3 score.

Data analysis

The collected quantitative and qualitative social survey data were coded and analyzed using the IBM Statistical Package for Social Science (SPSS) software, version 21.0 as described by Jones *et al.*, (2014). Cross-tabulation tables were constructed, and descriptive statistics were generated to summarize data from the questionnaires. To make statistical inferences, descriptive statistics, frequencies and percentages were conducted to analyze relationships between variables.

Results

Description of the surveyed households:

The summary of household characteristics of the respondents was presented in Table 1. Out of 240 farmers interviewed 182 and 58 were males and females, respectively. This suggested that there was gender disparity in all tested districts. The wide gap between the number of males and females participating in the study was higher in Seka-chekorsa (27 males and 3 females) and in Shebe-sombo (23 males and 8 females). The proportion of males (22) was greater than that of females (10) in Sheko. The high percentage of male farmers suggested to their access to farm land and their position as head of the family. In this study, 103, 69 and 68 of the farmers had followed Orthodox, Muslim and Protestants, respectively. The mean age distribution of the farmers between districts revealed that the highest (55.08) and the lowest (45.62) ages was recorded in Dedo and Sheko districts, respectively (Table 1).

Table 1: Household characteristics of the surveyed districts in southwest Ethiopia

Districts	Number of farmers	Religion			Sex		Mean age of farmers	Mean family size	Mean farm size(ha)
		Ortho	Mus	Pro	Male	Female			
Dedo	38.0	20.0	8.0	10.0	28.0	10.0	55.08	8.00	1.63
Kersa	42.0	22.0	13.0	7.0	30.0	12.0	47.83	6.19	0.86
Manna	35.0	9.0	22.0	4.0	28.0	7.0	47.46	6.08	1.47
Seka-chekorsa	30.0	10.0	17.0	3.0	27.0	3.0	51.67	6.80	1.44
Shebe-sombo	31.0	19.0	7.0	5.0	23.0	8.0	52.35	6.90	1.40
Sheko	32.0	8.0	0.0	24.0	22.0	10.0	45.62	6.43	1.13
Yeki	32.0	15.0	2.0	15.0	24.0	8.0	50.11	6.80	1.51
Total	**240.0**	**103**	**69.0**	**68.0**	**182.0**	**58.0**	**350.1**	**47.20**	**9.44**
Mean	**34.28**	**14.7**	**9.85**	**9.71**	**26.0**	**8.28**	**50.01**	**6.74**	**1.35**

Ortho: Orthodox, Mus: Muslim, Pro: protestant

From the total, 202 farmers in the seven districts comprised 6-7 individuals and only 38 households embraced eight people. The number of individuals per household influenced farming operations requiring human labor. Households with more than five family members were more efficient in yam farming than families with fewer members, which predominantly outsourced their labor needs from their communities or cultivated only a small portion of their land. Most respondents (198) had more than one hectare, very few (42) farmers in Kersa had 0.86 hectare of land (Table 1).

Crop production in the study areas:

In all tested districts, farmers depended on both crops and livestock as major sources of food and income. The mean area of land being cultivated by each interviewed individual farmer ranged from 0.86-1.63 ha with a mean of 1.35 ha. (Table 1). Crops grown in the study districts included maize (*Zea mays*), coffee (*Coffea arabica*), wheat (*Triticum aestivum* L.), and taro (*Colocassia esculenta* (L.), yam (*Dioscorea spp*.), millet (*Eleusine coracana* L. Gaertn), tomato (*Lycopersicum esculentum* L.), cassava (*Manihot esculenta* Crantz), potatoes (*Solanum tuberosum* L.) and cabbage (Table 2). From the total respondents, 24.58, 18.75 and 17.08 % of farmers' cultivated maize, coffee and yam, respectively. Some crops were grown in specific districts. For example, potato was grown in Dedo, Kersa and Manna districts, occupying 2.08% of the total respondents. Similarly, the number of farmers who cultivated cassava in Manna was almost equal to that of tomatoes in Seka-chekorsa and Shebe sombo districts (Table 2).

According to the farmers, most of the crops were grown during the rainy season, i.e. from March-June in Dedo, Kersa, Manna, Seka-chekorsa and Shebe-sombo and from October-February in Sheko and Yeki districts (Table 2). Furthermore, some socio-economic parameters related to the households surveyed such as the age of the households and family size affect the farmers' decision making in the number of crop production.

Table 2: Number of farms covered by major crops during 2015/2016 cropping season in seven tested districts of southwest Ethiopia

Crops	Districts							Total farms	Percents (%)
	Dedo	Kersa	Manna	Seka chekorsa	Shebe sombo	Sheko	Yeki		
Maize	11	12	8	7	8	5	8	59	24.58
Coffee	10	8	7	2	9	6	3	45	18.75
Wheat	6	4	5	2	3	0	0	20	8.33
Taro	1	3	1	8	3	6	6	28	11.67
Yam	8	7	3	4	2	8	9	41	17.08
Millet	1	4	5	2	2	0	4	18	7.50
Tomatoes	0	2	3	1	1	7	0	14	5.83
Cassava	0	0	1	1	1	0	2	5	2.08
Cabbage	0	0	0	3	2	0	0	5	2.08
Potato	1	2	2	0	0	0	0	5	2.08
Total	**38**	**42**	**35**	**30**	**31**	**32**	**32**	**240**	**100**

Yam production constraints

Yam production constraints faced by farmers in the seven districts are summarized in Table 3. The major constraints included, low attention given to the crop, drought at early stage of the crop, replaced yam farms by high value crops, wild animal attacks, stake and labor shortages, low soil fertility, shortage of farm land and low extension service. Further, during group and key informant discussion, some farmers identified drought at early stage as the main yam production constraint, followed by dilution of the crop by improved cereals technologies. Farmers' ranking production constraints across districts showed yam production was highly constrained by wild animal attacks. The main animals reported were porcupine (13.93%) and mole rat (9.29%) (Table 3). However, farmers in all districts reported, some landraces used as medicine are not preferred by porcupine and mole rats. This might be due to medicinal yams had high poly phenols or tannin like compound and not favorite by wild animals. High porcupine attacks, reported mainly in Dedo (17 farmers), Sheko (15 farmers) and Shebesombo (13farmers) districts, respectively. Apart from the wild animal attacks, the other most yield-limiting factor in the study areas was low attention given to the crop by farmers and accounted 14.71% of the total respondents (Table 3). In all tested districts, many farmers' confirmed, young people today have less interest in yams as compared to grains. In addition, more productive maze varieties have been introduced by agricultural extension workers, who also encourage intensive cultivation practices and contend area and labor force from yam production.

Severe drought at early stage was reported by 14.4% of the respondents across all studied districts (Table 3). Most of the farmers interviewed, yam planting was done in October and November and moisture stress

happened at the emergence and subsequent months thus the plant became stunted in its growth. To alleviate drought stress problem, farmers adopted various strategies, such as inter crop yam with maize and early planting in all districts. Apart from the drought, change yam farms by cereals were also another cause of reduced yam production in the tested districts. About 11.15% of the respondents reported yam farms replaced by more economical (cereal) crops (Table 3). In Sheko and Yeki, agricultural extension workers are more knowledgeable and enthusiastic about grains, especially maize and less familiar with root and tuber crops. Furthermore, many people from northern Ethiopia had settled in all surveyed districts, often achieving majority status over the indigenous people. Having grown grains in their former region, most northerners despise yam landraces and eat them only when absolutely necessary. Thus, yam landraces have come to be regarded as low status relative to the grains sown by extension workers and new comers. Furthermore, due to the superior qualities of modern varieties (especially higher yields and higher prices), farmers increasingly replaced yam landraces by modern varieties in many fields.

Changing climatic conditions are also resulting in the loss of adaptation of some formerly high yielding landraces, forcing farmers to shift to new, better adapted landraces. Shortages of farm land (11.46%) and labor (3.56%) were also other constraints mentioned by farmers as causes of yield-limiting factor for yam in the study areas (Table 3). According to the farmers', high population pressure and city expansion in different districts are the main cause of land shortage. Further, the high rate of urban migration, especially among younger people has reduced the labor force in Sheko (13) and Dedo (5) districts. Staking is one the most agronomic practice in yam production. Similarly, 7.59% of the farmers confirmed stake shortage was considered as a yield limiting factor for yam and highly associated with the cost of the stake in the areas.

This problem is common in Manna and Dedo districts of Jimma zone (Table 3). Decline in soil fertility (0.46%), as a result of frequent cultivation of the land without furrowing was evident and some landraces have therefore been abandoned due to low productivity.

Table 3: Yam production constraints in Dedo, Kersa,Manna, Seka–chekorsa, Shebe-sombo, Sheko and Yeki districts in southwest Ethiopia

Causes	**Dedo **38**	**Kersa **42**	**Manna **35**	**Seka chekorsa **30**	**Shebe sombo **31**	**Sheko **32**	**Yeki **32**	**Total**	**Percent**
Low attention given to the crop	11.0	20.0	18.0	17.0	16.0	8.0	5.0	95	14.71
Drought at early season	31.0	3.0	7.0	2.0	9.0	18.0	23.0	93	14.40
Porcupine attack	17.0	7.0	5.0	25.0	13.0	15.0	8.0	90	13.93
Need more management	4.0	20.0	14.0	10.0	6.0	8.0	20.0	82	12.69
Shortage of farm land	8.0	17.0	13.0	4.0	2.0	8.0	22.0	74	11.46
Replaced by high value crop	16.0	4.0	7.0	2.0	2.0	17.0	24.0	72	11.15
Attacked by mole rat	0.0	14.0	3.0	10.0	18.0	7.0	8.0	60	9.29
Shortage of stake	11.0	0.0	13.0	10.0	12.0	1.0	2.0	49	7.59
Labor shortage	5.0	0.0	0.0	3.0	2.0	13.0	0.0	23	3.56
Low market value	0.0	2.0	2.0	0.0	0.0	0.0	0.0	4	0.62
Low soil fertility	0.0	2.0	0.0	1.0	0.0	0.0	0.0	3	0.46
Lack of extension service	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	0.15

Figures in parenthesis refer to number of farmers surveyed in each district. Source: own survey result, Sum greater than 100 is due to double counting.
** sign indicate different significance level.

Yam landraces grown in tested districts

In all tested districts, farmers identified 38 known farmers named yam landraces (Table 4). Of these four landraces, (liyan, offea, welmeka and woko) belongs to well definite species of aerial yam and are recognized based on the differences of bulbils shape, color, size and surface texture. Moreover, one species called badaye belongs to *Dioscorea* alata basically identified by early maturity and a square vine with tubers varying in shape, and white, creamy yellow or purple flesh color. Nevertheless, these characters not give the impression to provide reliable means of identification, as it tends to differ within a landrace. The other landraces are hardly identified as a species or group of species. Furthermore, wild yams widely named as sasa and karakachi were identified in forest areas of Manna and Sheko districts by having big thorns on the surface of the vine and underground tuber. The disparity in the number of yam landraces planted per farm across the tested districts was summarized in Table 4. From all districts, a relatively large number of farms having five or more landraces were found in Kersa, Manna, Shebe-sombo and Seka-chekorsa districts of Jimma zone. Conversely, moderate number of farms having four landraces was found in Sheko and Yeki districts of Bench-maji and Sheka zone of southwest Ethiopia.

Table 4: Yam landraces recorded in the study districts of southwest Ethiopia and number of farms they were encountered

No	Name of landraces	Districts							Total
		Dedo	Kersa	Manna	Seka chekorsa	Shebe sombo	Sheko	Yeki	
1	Afra	-	2	2	-	1	3	-	8
2	Anchiro	13	18	8	8	8	-	-	55
3	Badaye	1	-	-	-	-	18	21	40
4	Badenseye	-	-	-	-	-	-	2	2
5	Baki boye	2	-	1	-	-	1	2	6
6	Bambuche	1	-	4		1	-	-	6
7	Banda	-	-	-	-	-	4	3	7
8	Bola boye	-	-	-	-	2	-	-	2
9	Bori boye	-	-	-	-	-	3	-	3
10	Chebesha	-	-	-	-	-	5	1	6
11	Dakuy	-	-	-	-	-	2	4	6
12	Dapo	-		2	-	-	-	-	2
13	Dartho	13	6	1	5	7	-	-	32
14	Doni	-	-	-	-	-	4	20	24
15	Erkabea	-	-	-	-	-	-	2	2
16	Feda	4	-	-	2	-	-	-	6
17	Geano boye	2	17	8	7	7	-	-	41
18	Gesa boye	-	-	-	-	2	-	-	2
19	Goshitea	12	7	4	6	3	-	-	32
20	Gurshume	14	6	2	-	5	-	-	27
21	Hati boye	-	10	2	1	1	-	-	14
22	Karakachi**	-	-	-	-	-	7	-	7
23	Kerta boye	6	-	-	2	1	-	-	9
24	Liyan*	-	-		-	-	-	9	9
25	Mecha boye	3	-	2	-	-	-	-	5
26	Offea*	-	18	4	6	4	-	-	32
27	Pada	2	-	3	2	-	-	-	7
28	Sesa**	1	-	1	-	-	-	-	2
29	Torebea	-	-	-	-	-	4	-	4
30	Tsedeboye	-	-	-	-	-	2	-	2
31	Wadela boye	-	2	2	1	3	-	-	8
32	Woko*	-	-	-	-	-	3	13	16
33	Washinea	-	-	-	-	-	-	7	7
34	Wayera	6	-	-	-	-	-	-	6
35	Welmeka*	-	3	7	-	2		-	12
36	Zankur	-	-	-	-	-	6	-	6
37	Zatemera	-	-	3	-	-	-	-	3
38	Zawera	4	-	-	-	-	-	-	4

* = Aerial yams, ** = wild yams,

Distribution of yam landraces

The distribution of yam landraces in conventional farms is determined by adapting to environmental stresses, drought tolerance, high market value, seed availability, ability to adapt to different climatic conditions and farmers' objectives. The outline of yam distribution within and towards the districts follows increasing diversity. In the present study, 16

landraces had a narrow distribution and specified a single district (Table 4). The remaining 22 landraces were found in more than one district. In the whole surveyed areas, there is no common landrace had found in all districts. This confirms the real picture in regard to the abundance and distribution of yams in Southwest Ethiopia. From the total of surveyed districts, five landraces (anchiro, dartho, geano boye, goshitea and gurshume) were found in all districts of Jimma zone. However, four landraces such as banda, chebesha, doni and woko were found only in Sheko and Yeki districts of Southwest Ethiopia. Besides, there were considerable differences with regarding to the number of farms where the landrace were found. Yam landraces such as, anchiro, badaye, geano boye, goshitea, dartho and offea are the most abundant landraces as they accounted 231 in number from the total landrace of the surveyed districts. Few landraces were well represented in some districts, but almost missing from the others. For example, doni was found on 24 farms visited in Yeki. Outside of this district, it was only established in Sheko with a very low in number (4). Similarly, offea was found in most districts from the Jimma zone and its abundance is high and 18 farms in Kersa and was narrow in out of this district, for example, 4, 6 and 4 farms in Manna, Seka chekorsa and Shebe sombo, respectively. Nevertheless, the distribution of offea in Sheko and Yeki was nil. This confirmed that, the abundance and distribution of some landraces were regional and district specific and was found in one region or district and missing in other districts and their distribution is highly associated with geographical variation.

The trends of the distribution and abundance of landraces in the districts of the Jimma zone were comparatively diverse. The landraces described in these districts were local (189 and rare (51). In most diverse districts of Dedo and Manna, the majority of the landraces were quite distributed with a relatively lower but comparable abundance. This reflected higher evenness of landrace abundance in these districts. The least diverse districts of Sheko were similar to that of Yeki. The landrace described in Sheko and Yeki were rare, unique and most of the landrace hardly exist in the districts from Jimma zone. The variation among districts with respect to the distribution and abundance landraces also evident from the number of farms surveyed and corresponding number of landraces recorded. Furthermore, variation between zones with regard to the distribution and abundance of landraces also varied. From the total surveyed study areas, 21, 5 and 3 landraces were found in Jimma, Bench-maji and Sheka zones, respectively. Besides, some landraces were found between zones of Southwest Ethiopia. For example, five landraces found in areas between Sheko and Yeki, while three landraces in areas between Jimma and Sheko.

Additionally, only two landraces were found in some districts of Jimma, Bench maji and Sheka zones in Southwest Ethiopia.

Farmer-preferred traits

The summery of farmers' preferred traits of yam in all tested districts was presented in Table 5. Based on the surveyed result, there were many selection practices were approved by farmers' based on their indigenous knowledge. Farmers in the study areas selected yam landraces for production on the basis of tuber yield, good market price, good taste, good tuber and bulbils flesh color, powdery after boil, medicinal use, maturity, ease to harvest, drought tolerance, disease and insect pest resistance (Table 5). In addition, women considered taste to be an important trait of making yam porridge. Farmers in Sheko considered yams as medicinal use to be an important trait and they usually received high market prices. Farmers preferred early-maturing landraces, which could escape seasonal food shortage, drought and diseases. Some landraces had distinct, market-preferred traits, such as tuber color, which varied across markets. For instance, in Manna, Dedo, Shebe-sombo, Seka-chekorsa and Kersa districts, white color was preferred, whereas farmers in Sheko and Yeki preferred a red color. Large tuber size of yams, early maturing and resistance to diseases were some of the other traits preferred by farmers in the study areas. The mean farmers' preferred traits of yam in the seven districts were tuber yield 35.42%, market preference 11.05%, taste 6.71%, flesh color 5.91%, powdery after boil 10.48%, medicinal use 5.58%, maturity 8.86%, ease to harvest 7.25%, resistance to drought 5.23% and disease and pest resistance 3.53% (Table 5).

Table 5: Farmer-preferred traits (% farmers) of yam landraces in Dedo, Kersa, Manna, Seka–chekorsa, Shebe-sombo, Sheko and Yeki districts in southwest Ethiopia.

Criteria	Districts							Mean	Rank
	Dedo	Kersa	Manna	Seka chekorsa	Shebe sombo	Sheko	Yeki		
Tuber yield	34.21	35.71	34.29	33.33	32.26	34.38	43.75	35.42	1
High market price	13.16	14.29	11.43	10.00	9.68	9.38	9.38	11.05	2
Good taste	5.26	7.14	5.71	6.67	9.68	6.25	6.25	6.71	6
Good flesh color	5.26	4.76	5.71	6.67	6.45	6.25	6.25	5.91	7
Powdery after boil	10.53	9.52	11.43	13.33	12.90	15.63	0.00	10.48	3
Medicinal use	5.26	9.52	11.43	3.33	3.23	3.13	3.13	5.58	8
Maturity	7.89	7.14	8.57	10.00	9.68	9.38	9.38	8.86	4
Ease to harvest	5.26	4.76	5.71	6.67	6.45	9.38	12.50	7.25	5
Drought tolerance	5.26	0.00	5.71	6.67	6.45	6.25	6.25	5.23	9
Disease and insect pest resistance	7.89	7.14	0.00	3.33	3.23	0.00	3.13	3.53	10

Farmers' awareness on tuber yam and/or aerial yam landraces

In the present study, 50.97%, 13.78% and 35.25% of respondents familiar about storage tuber, aerial yam and both yam types preferred, respectively (Table 6). In Dedo 31.6%, Kersa 45.24%, Manna 60%, Seka-chekorsa 53.33%, Shebe-sombo 32.26%, Sheko 78.12% and Yeki 56.25% of the respondents were familiar about tuber yams. Given a chance to choose and grow among the aerial and tuber yams, 35.25% responded to growing both yams types (Table 6).

Table 6: Preference of farmers (% farmers) to grow tuber yam and/or aerial yam landraces in Dedo, Kersa, Manna, Seka–chekorsa, Shebe-sombo, Sheko and Yeki districts of southwest Ethiopia

Types of yams	Districts							Mean
	Dedo	Kersa	Manna	Seka Chekorsa	Shebe Sombo	Sheko	Yeki	
Tuber yam	31.58	45.24	60.00	53.33	32.26	78.12	56.25	50.97
Aerial yam	15.79	21.43	14.29	10.00	19.35	3.12	12.5	13.78
Both	52.63	33.33	25.71	36.67	48.39	18.75	31.25	35.25

Discussions

The results of the present study revealed that yam production practices mainly dominated by male farmers (Table 1). The lower percentage of female farmers could be due to the former land ownership system which discriminated against women in all surveyed areas. In this regard, a similar study was conducted by Tamiru *et al.,* (2011) who reported that most farming activities are a male dominated profession. In smallholder farming communities, farmers' are the major source of labor and depends on the family size (Alieu *et al.,* 2012). Hence, the larger the household size, the greater the labor force available, and, in chance, the larger the area of land cultivated. Households with only two or three members had limited labor, and therefore, they usually cultivated areas of less than one hectare. Households of five or more members cultivated areas of more than 2 ha. Similarly, Zimmerer, (1992) and Loko *et al.,* (2015) reported that land and labor shortages are the main factor that threatens yam production in Benin. The study also showed that most active farmers were between 45 and 55 years of age in all districts (Table 1). This was due to farmers who have less than 40 years of age had other jobs in neighboring towns.

Yam grown mainly to fill food and economical gaps in all districts. Crops, such as maize, coffee, wheat, taro, yam, millet and cassava were grown specifically for food security and tomato, potatoes and cabbage were grown for cash. Farmers used yam as a source of food (yam flour mixed with wheat), roasted tuber and porridge (Scarcelli *et al.,* 2011). Most of the

farmers in tested districts preferred yam landraces that were described by high tuber yield, high market price, white and purple flesh, powdery after boil, early maturity, ease to harvest, medicinal use, drought tolerance and disease and insect pest resistance (Loko *et al.,* 2013; Loko *et al.,* 2015). According to Fekadu *et al.,* (2015) reported that farmer-preferred cultivars had large sized and orange color of sweet potato in southern Ethiopia. Further, Alieu *et al.,* (2012), reported farmer's preferences to maintain yam landraces are highly depending on their socio cultural value, foods and income source. The results from this study further showed that most of the farmers were alert of the constraints affecting their crops. Low attention given to the crop, drought, animal attacks, poor management, and shortage of farm land, dilution of the crop by improved cereal technologies, labor shortage, low soil fertility and poor extension service were reported to be the main limiting factors in yam production in all study districts (Table 3). In this regard, different researchers reported different factors that affected the production of different crops. For example, Fekadu *et al.* (2015) reported drought affects the yield of orange fleshed sweet potato grown in South Ethiopia. Further, Firew, (2012) and Happy *et al.,* (2018) who reported, floods, drought and wild animal attacks affect production of sorghum and ground nut. According to Alieu *et al.,* (2012) reported that city expansion is the main factor that affects yam production in West Africa, and Firew, (2012) reported habitat fragmentation and over exploitation of natural resources are the cause that threaten Ethiopian crop genetic resources. Further, Loko *et al.,* (2013) reported storage insects are the major constraints that threatened yam genetic resources in Northern Benin. Farmers identify different landraces by their own descriptors with different names for management decisions (Loko *et al.,* 2015). They described their landraces in various ways and characters used to separate one from another (Scarcelli *et al.,* 2011; Tewodros, 2016). In all tested districts, a total of 38 farmers named landraces was identified by farmers for their different preferred traits.

This study designed through the participatory approach for conversation made between yam growers and yam researchers helped understand the main constraints to yam production identified by farmers in the Jimma, Bench-maji and Sheka zones of southwest Ethiopia. In this discussion, confirmed that all farmers were recognized on yams and its major production constraints. Owing to the past research neglect, farmers are often the only sources of information on yam in Southwest Ethiopia. Therefore, through the analysis of indigenous knowledge, farmers' perception in designing breeding and conservation programs are critical so as to bring practical solutions to the identified problems of the farmers in the study areas (Tamiru *et al.,* 2011) Further, in most cases, farmers' preferences are

mainly based on very specific needs and socio-cultural aspects; thus, research in collaboration with farmers becomes necessary to establish new ways of a dialogue between researchers and farmers in evaluating the characteristics of the landraces farmers' maintained in their system.

Conclusion and Recommendation

Low attention given to the crop was the major constraint for yam production followed by drought and wild animal attacks. Farmers in the study areas depended on agricultural production, such as livestock rearing and growing a range of crops, in addition to yam, for food and income generation. In all districts, 38 farmers' named landraces identified with variable distribution. Thus, farmers' indigenous knowledge of yam and local landraces must be collected, analyzed and properly documented for the research and development program in the country. In this study, high yield, good market price, powdery after the boil, early maturity and drought tolerance are the main yam traits preferred by farmers. Therefore, researchers could use farmers' identified /preferred traits as selection criteria in their breeding program to boost yam production in Southwest Ethiopia.

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