



Released Crop Varieties and their Packages in Western Zone of Tigray, Ethiopia

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

North western and Western zone of Tigray are the most suitable for agricultural mechanization and investment for different crops such as sesame, cotton, sorghum, Mungbean and other. Now days different investments and agro-industries are emerging to consume and process the agricultural products and this is a good opportunity for the crop producers. This new emerging industrial parks helps to produce quality products, value-add process, to get reasonable price, to introduce modern agriculture and agricultural mechanization. The Humera type sesame is one of the branded white seeded sesame in the world, meets the world criteria; it has high demand in the world market for different purposes. In northern Ethiopia, sesame is producing purely organic and it is very essential for different international and domestic purposes. Humera agricultural research Center released different crop varieties under wide commercial production in different agro-ecologies of Ethiopia such as sesame; Setit-1(2011), Setit-2 (2016), Setit-3 (2017), Humera-1 (2011) and Mungbean (Arkebe, 2014), Okra (Bamya-Humera in2016), Tomato (Tekeze-1, 2016) for low land areas of

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northern Ethiopia and other similar agro-ecology of the country. Those released crop varieties are under wide commercial production and small-scale farmers in northern Ethiopia and producing for export, agro-industrial purposes and local consumption.

Keywords: Variety; crop name; seed yield; oil content; released year; seed color.

1. INTRODUCTION

Mi'irabawi (or "Western") is the westernmost Zone of the Tigray Region in Ethiopia. It is subdivided into three woredas (districts); from north to south they are Kafta Humera, Wolqayt and Tsegede. Major towns and cities include Humera. Mi'irabawi is bordered on the east by the Semien Mi'irabawi (North Western) Zone, the south by the Amhara Region, the west by Sudan and on the north by Eritrea. Semien Mi'irabawi Zone was split off from Mi'irabawi in 2005.

[1] Total cultivated land of western zone of Tigray is around 554996 hectare from this during 2016/2017 main cropping season 276306 hectare was covered with sesame [2]. Humera (Ge'ez ከሙራ) is a city in Kafta Humera woreda in the Tigray Region (or kilil) of Ethiopia. It is located in the Mi'irabawi Zone of the Tigray Region at longitude and latitude 14°18'N 36°37'E, with an elevation of 585 meters (1,919 ft) above sea level and the Tekezé river flows to the west. Humera is the important Ethiopian city south of the border with Eritrea and Sudan, and is considered to be a strategically important gateway to Sudan [3]. Low land crops, Sesame, cotton, sorghum, pearl millet, soybean, haricot bean, Mungbean, sunflower safflower, fruits (Banana, mango, date palm, lemon, orange, guava), vegetables (okra, tomato, pepper, onion, eggplant, watermelon, pumpkin, High land crops (lentil, linseed, safflower, faba bean, barely, wheat).

2. MATERIALS AND METHODS

The study was conducted in western zone of Tigray at six locations at different environments. According to internationally and nationally selection criteria and locally market preference selected for variety verification trial. The candidate varieties evaluated by the national technical released committee for release as variety for commercial production comparing with standard and local checks.

2.1 Ethiopia Map

Humera Agricultural research center is established in 2003 and now it is one of the

research centers in Tigray region in western zone with mandate areas of high lands, low lands and middle lands [5]. This center mainly working on field crops such as sesame, sorghum, cotton mungbean, soybean rice, wheat, barley, Faba bean and horticultural crops; banana, mango, okra, tomato, garlic etc. in all agro-ecologies. Our center is also national sesame coordinator in addition to the regional activities and continuously releasing crop varieties from 2011 onwards such as sesame; setit-1, setit-2, setit-3, humera-1, Mungbean (Arkebe), okra (Humera-Bamya), tomato (tekeze-1) summing up seven crop varieties were released and now actively working in crop improvement to ensure farmers food security in the area as well as in the national. The released crop varieties are under extensive commercial production in northern Ethiopia and the other regions. The sesame varieties are expanding from time to time from Ethiopia north to the whole country because of their quality, good color and good aroma, high yield, early and suitable for sesame producing areas.

2.2 Mungbean

Mungbean [*Vignaradiata* L.] belongs to the family Leguminosae. It is a small herbaceous annual plant growing to a height of 30 to 120 centimeters with a slight tendency to twining in the upper branches. The central stems are more or less erect while side branches are semi-erect. The leaves are 5-10 cm long trifoliate with long petioles. Both the stems and leaves are covered with short hairs, generally shorter than Black gram. The pods are linear, sometimes curved, ground and slender with short pubescence. The seeds are small and nearly globular. The color of seed is usually green, but yellow brown or purple brown seeds also occur. The color of cotyledons is yellow. The crop is fully self-fertile and self-pollinated. Mungbean (*Vignaradiata* (L.) R. Wilczek var. *radiata*) is one of the most important food legume crops in South, East and Southeast Asia, where 90% of global production currently takes place. Mungbean is a relatively drought-tolerant and low-input crop that can provide green manure as well as livestock feed and thus is flavored by smallholder farmers.

Table 1. Description of studied areas

Description	Locations				
	Kebabo	Banat	Humera	Maygaba	Adigoshu
Altitude(m.a.s.l)	696	593	609	896	940
Latitude (°N)	13°36'	13°78'	14°15'	13°98'	14°05'
Longitude (°E)	36°41'	36°48'	36°37'	37°68'	37°17'
R.F. (mm)	888.4		576.4	NA	NA
Temp. (°C)	28	NA	18.8-37.6	NA	NA
Soil type	Vertisol	Chromic vertisol	Chromic Vertisol	Vertisol	Vertisol

Sources: [4]

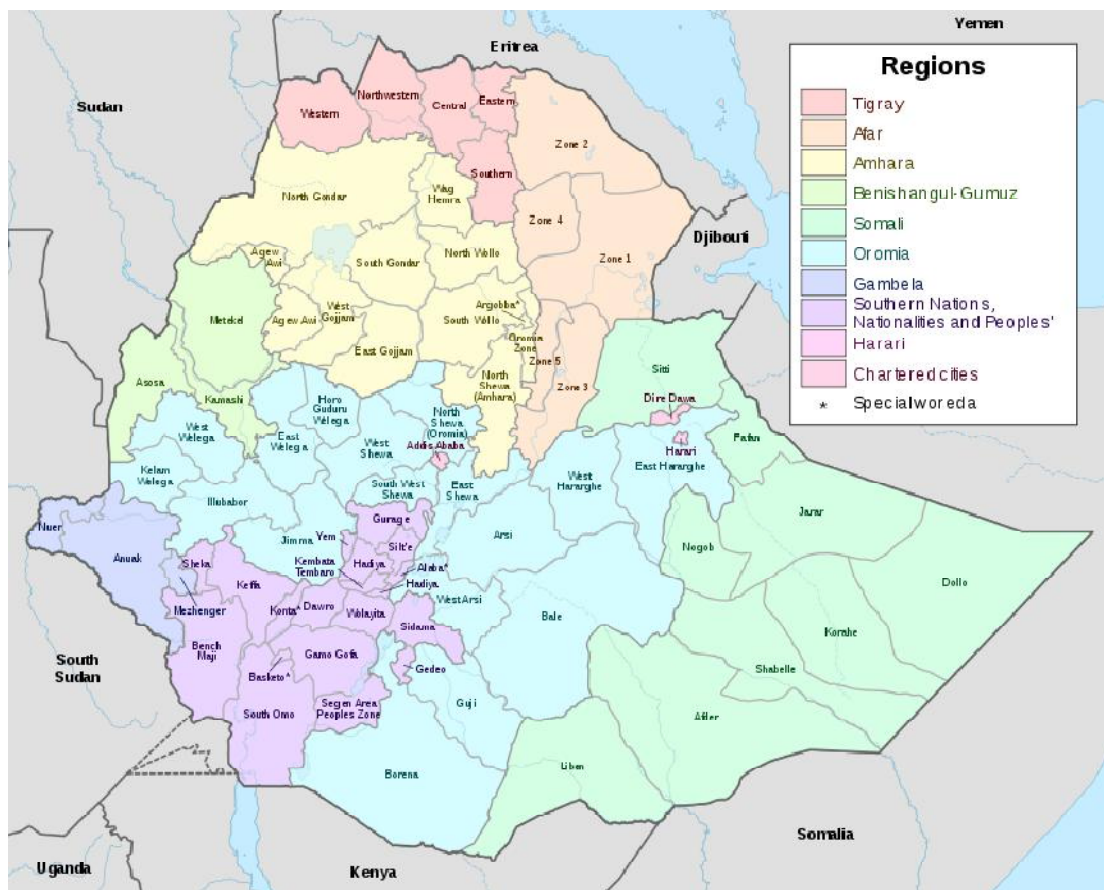


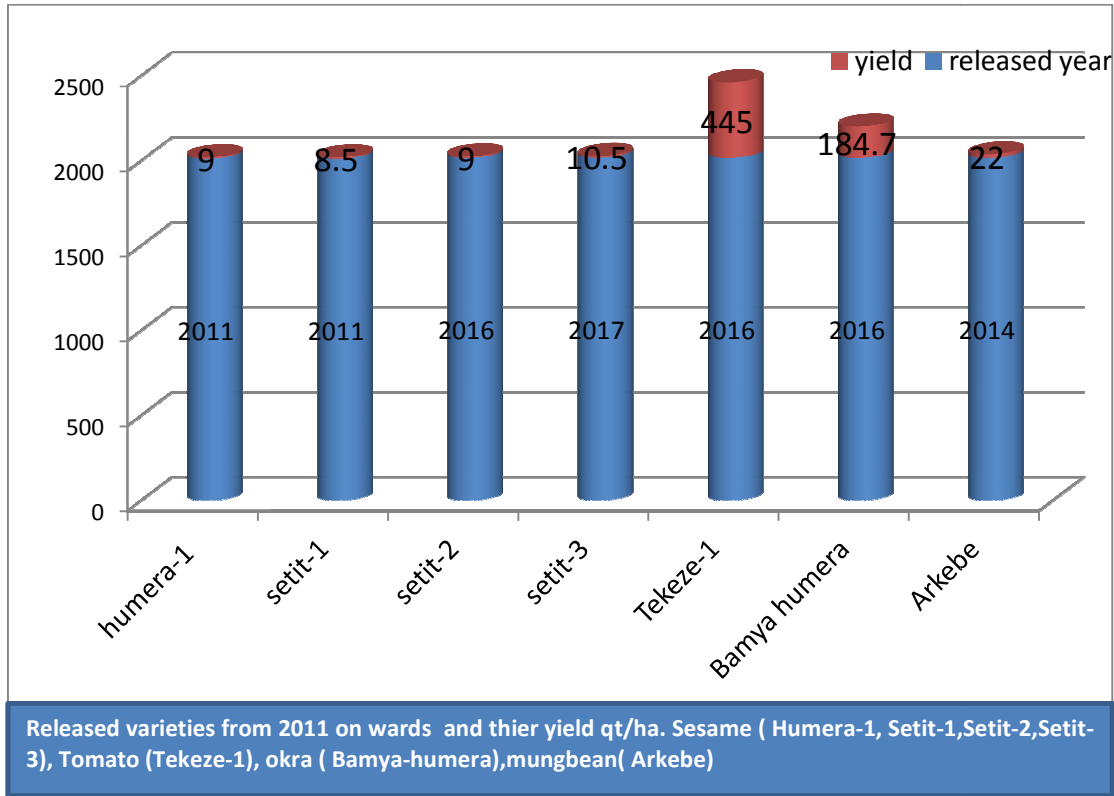
Fig. 1. Ethiopia map

Mungbean is one of the important pulse crops in India and in Ethiopia. It has been reported that mungbean has been cultivated in India since ancient times. It is believed that Mungbean is a native of India and Central Asia and grown in these regions since prehistoric times. It is widely cultivated throughout the Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos,

Cambodia, Vietnam, Indonesia, Malaysia, south China, and Formosa. In Africa and U.S.A. it is probably recent. Mungbean is a protein rich staple food. It contains about 25 percent protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. It is consumed in the form of split pulse as well as whole pulse, which

is an essential supplement of cereal based diet. It is particularly rich in Leucine, Phenylalanine, Lysine, Valine, Isoleucine, etc. In addition to being an important source of human food and animal feed, Mungbean also plays an important role in sustaining soil fertility by improving soil

physical properties and fixing atmospheric nitrogen. It is a drought resistant crop and suitable for dry land farming and predominantly used as an intercrop with other crops. In Ethiopia Mungbean is growing in Tigray, Amhara, Oromia, southern Ethiopia and Benushangul gumuz.



Released year, varieties name and yield qt/ha

1. Crop name: Mung bean/green gram/
 - 1.1 Variety/accession/name: Arkebe (SML)
2. Agronomy and morphological characteristics.
 - 2.1 Adaptation area: moisture-stressed areas of Humera and similar agro ecologies of green gram growing areas
 - Altitude (m.a.s.l) 560-760
 - Rainfall (mm) 400-650
 - 2.2 Seed rate (kg/ha) row planting (25-30kg/ha)
 - 2.3 Distance b/n raws and plants 30cm x 10cm
 - 2.4 Planting date mid-June- early July
 - 2.5 Days to flowering 32-37
 - 2.6 Days to maturity 60-68
 - 2.7 Seed color green
 - 2.8 Fertilizer required 100kg/ha DAP
 - 2.9 Yield (qt/ha)
 - Research field 20-24
 - Farmers field 13-17
3. Year of release 2014
4. breeder/maintainer Humera ARC/ TARI



Vegetables

Vegetable are important protective food for the maintenance of health and prevention of disease. It contains valuable food ingredients, which can be successfully utilized to build up and repair the body [6,7]. Vegetables are valuable in maintaining alkaline reserve in the body. They are valued mainly for their high vitamin and mineral content [8]. The production of vegetable has become very popular in many countries of the world due to its importance in the diet of the people. The production of vegetable has been recognized as the most affordable and accessible sources of micronutrient, which is increasingly regarded as a catalyst for rural development and as a means of increasing and generating foreign exchange in Africa [9].

2.3 Okra (*Abelmoschus esculentus*)

Okra is the most important fruit vegetable crop and a source of calorie (4550Kcal/kg) for human consumption. Okra cultivation and production has been widely practiced because of its importance to the economy development and can be found in almost every market in Africa. Okra contains carbohydrate, protein and vitamin C in large quantities [10]. The community in Western zone of Tigray believed that okra has many medicinal values rather than appetizer due to this reason this crop producing in every home garden both under rain fed and irrigation condition. Okra is finding in every market and every dish in western zone of Tigray. The society prepare as spouse mixing with meat, shiro, kikiie, silsi and others dishes as fresh/powder[6].

1. Crop name: Okra
- 1.1. Variety/accession/ name: Bamyia-Humera (Acc#23793)
2. Agronomy and morphological characteristics
 - 2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country
 - Altitude (m.a.s.l) 609-696
 - Rainfall (mm) 563-888
 - Temperature (C°) 18.8-37.6
 - 2.3 Seed rate (kg/ha) row planting (5.5-8kg/ha)
 - 2.4 Distance b/n raws and plants 45cm x 30cm
 - 2.5 Planting date mid-June- mid August
 - 2.6 Days to first picking(maturity) 45-53
 - 2.7 Pod color green
 - 2.8 Fertilizer required 100kg/ha DAP and 100kg/ha UREA
 - 2.9 plant height (cm) 150-170
 - 2.10 number of pods per plant (cm) 18-24
 - 2.11 green pod size (g) 32-38
 - 2.12 Yield (qt/ha)
 - Research field 184.7
 - Farmers field 140-160
 - 2.13 crop pest reaction relatively tolerant insect pests
3. Year of release 2016
4. breeder/maintainer Humera ARC/ TARI



Tomato

This new variety (Tekeze-1) is released for industrial purposes rather than local consumption since its fruit is small in size but give high yield. In addition to high yield this variety no need of staking because of short and erect morphologically this also another advantage over the other varieties.

1. Crop name: Tomato
- 1.1 Variety/accession/ name: Tekeze-1 (CLN-5915-93-D4)
2. Agronomy and morphological characteristics
 - 2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country
 - Altitude (m.a.s.l) 609-696
 - Rainfall (mm) 563-888
 - Temperature (C°) 18.8-37.6
 - 2.2 Seed rate (kg/ha) row planting (5.5-8kg/ha)
 - 2.3 Distance b/n raws and plants 45cm x 30cm b/n rows and plants respectively
 - 2.4 Planting date mid-December
 - 2.5 Maturity 72
 - 2.6 Pod colour Red
 - 2.7 Fertilizer required 200kg/ha DAP and 100kg/ha UREA
 - 2.8 plant height (cm) 50-56
 - 2.9 number of pods per plant (cm) 18-24
 - 2.10 fruit size (g) 34-38
 - 2.11 number of fruits /plant 60-90
 - 2.12 Yield (qt/ha)
 - Research field 400-491
 - Farmers field 350-391
 - 2.13 crop pest reaction relatively tolerant insect pests
3. Year of release 2016
4. breeder/maintainer Humera ARC/ TARI



Sesame

Sesame (*Sesamum indicum* L.) belongs to family Pedaliaceae, is an important and ancient oil-yielding crop. It has an edible seed and has high quality oil [11]. Sesame in different countries has different names; til (Hindi), hu ma (Chinese), sesame (French), goma (Japanese), gergelim (Portuguese) and ajonjoli (Spanish) [12,13] reported that In Ethiopia sesame known as Selit in Amharic and Tigrigna, Sallet in Afan Oromo.

Sesame is an important oilseed crop grown for local consumption and export in Ethiopia and it ranks first in area of production and as export crop among oilseed crops grown in the country [14]. Ethiopia is among the world's top five producers of sesame and the third largest world exporter of the crop [15]. Sesame production is increasing from year to year, which is mainly driven by increasingly high export market demand and availability of suitable agro-ecologies [16].

Despite its nutritional and high market value oil crop, research on sesame has been limited worldwide and so that still it has been produced under traditional management practices. Yield of sesame is highly variable depending upon the growing environment, cultural practices and the type of cultivar [17]. The major constraints in sesame production worldwide are lack of widely adapting cultivars, shattering of capsules at maturity, non-synchronous maturity, poor stand establishment, lack of fertilizer responses and low management practices [18]. In the case of Ethiopia lack of improved seed supply and the accompanying extension service for producers is also main problem [19].

Minot and Sawyer [20] reported that about 28% productions decrement of sesame in Ethiopia is due to insect and diseases. Among the many insect pests affecting sesame production worldwide sesame seed bug (*Elasmolomus sordidus*), sesame webworm (*Antigastra catalaunalis*), termites, gall midge (*Asphondilia sesami*), green vegetable bug (*Nezara viridula*), African bollworm (*Helicoverpa armiger*) and jassids (*Orosius albicinctus*) have been recorded in Ethiopia.

Sesame seeds are highly valued for their high content of sesame oil, oil that is very resistant to rancidity. Sesame seeds are the main ingredients in tahini and the Middle Eastern sweet treat, halvah. Open sesame—the famous

phrase from the Arabian Nights—reflects the distinguishing feature of the sesame seed pod, which bursts open when it reaches maturity (<http://www.whfoods.com/index.php>: Accessed date December 2017). Sesame oil has desirable physiological effects, including antioxidant activity, and blood pressure- and serum lipid lowering potential [21]. Sesame oil has high content of flavored linoleic acid (C₁₈H₃₂O₂) and a particular feature is that it contains an antioxidant which prolongs the shelf-life of both the oil and other foods fried in the oil [18].

Sesame is used in wide range of applications [22]. The most important ones are: Edible oil: The oil is odorless with distinctive nutty sweet flavor. Roasted sesame seed resists rancidity due to the antioxidants formed during seed roasting. Sesame oil is especially important in the Far Eastern cuisine, mainly Japan and china, Confectionery, biscuit and bakery industry: Hulled clear white sesame is required for bakery products, Tahini industry: Tahini, a traditional Middle Eastern paste, is made from hulled sesame seed and is rich in protein, Halva industry: Halva is a sweet made of 50% Tahini, boiled sugar and some other ingredients, Sesame flour and sesame seed sprouts, Pharmaceutical ingredients.

North western and Western zone of Tigray are the most suitable area for agricultural investment in different crops such sesame, cotton, sorghum, mungbean and other crops. Now days the area is very continent for different investments and agro-industrial Park is under construction for different processing agricultural products. This industrial park helps us to produce quality products, value add process, to get reasonable price, to introduce modern agriculture and agricultural mechanization. The Humera type sesame is one of the branded white seeded sesame in the world, meets the world criteria; it has high demand in world market. In northern Ethiopia sesame is producing purely organic and it is very important for different purposes. Released sesame varieties and still under wide commercial production in different agro ecologies are the following:

1. Setit-1; released in 2011
2. Setit-2; released in 2016
3. Setit-3; released 2017
4. Humera-1; released in 2011

1. Crop name: sesame
- 1.1 Variety name: setit-1
2. Agronomy and morphological characteristics
- 2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country
 - Altitude (m.a.s.l) 600-800
 - Rainfall (mm) 563-888
 - Temperature (C°) 18.8-37.6
- 2.2 Seed rate (kg/ha) row planting (0.8-1.2 kg/ha) and Broad casting 2-3kg/ha
- 2.3 Distance b/n raws and plants 40 cm x 10 cm b/n rows and plants respectively
- 2.4 Planting date mind June-beginning July
- 2.5 Planting depth (cm) 3.5
- 2.6 Maturity 80-90
- 2.7 Seed color color white
- 2.8 Fertilizer required 100 kg/ha DAP and 50 kg/ha UREA
- 2.9 plant height (cm) 122.00
- 2.10 Length capsule bearing zone (cm) 59.15
- 2.11 number of capsules per plant 55.22-195
- 2.12 number of branches/plant 3.12
- 2.13 number of seeds /capsule 278.20
- 2.14 thousand Seed weight (gm) 3.20
- 2.15 Yield (qt/ha)
 - Research field 7-10
 - Farmers field 5.5-9
- 2.15oil content (%) 52
- 2.16 crop pest reaction relatively tolerant insect pests and diseases
3. Year of release 2011
4. breeder/maintainer Humera ARC/ TARI



1. Crop name: sesame
- 1.1 Variety name: Humera-1
2. Agronomy and morphological characteristics
- 2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country
 - Altitude (m.a.s.l) 600-1100
 - Rainfall (mm) 563-888
 - Temperature (C°) 18.8-37.6
- 2.2 Seed rate (kg/ha) row planting (0.8-1.2 kg/ha) and Broad casting 2-3kg/ha
- 2.3 Distance b/n raws and plants 40 cm x 10 cm b/n rows and plants respectively
- 2.4 Planting date mind June-beginning July
- 2.5 Planting depth (cm) 3.5
- 2.6 Maturity (days) 90-100
- 2.7 Seed color colour white

2.8 Fertilizer required	100 kg/ha DAP and 50 kg/ha UREA
2.9 plant height (cm)	122.80
2.10 Length capsule bearing zone (cm)	62.08
2.11 number of capsules / plant	49.39-220
2.12 number of branches/plant	3.46
2.13 number of seeds /capsule	314.50
2.14 thousand Seed weight (gm)	3.38
22.13 Yield (qt/ha)	
> Research field	8-10
> Farmers field	5-8
2.14 oil content (%)	54
2.15 crop pest reaction	relatively tolerant insect pests and diseases
3. Year of release	2011
4. breeder/maintainer	Humera ARC/ TARI



1. Crop name: sesame	
1.1. Variety/accession/name: Setit-2(J-o3)	
2. Agronomy and morphological characteristics	
2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country	
> Altitude (m.a.s.l)	600-1100
> Rainfall (mm)	563-888
> Temperature (C°)	18.8-37.6
2.2. Seed rate (kg/ha)	row planting (0.8-1.2 kg/ha) and Broad casting 2-3 kg/ha
2.3 Distance b/n raws and plants	40 cm x 10 cm b/n rows and plants respectively
2.4 Planting date	mind June-beginning July
2.5 Planting depth (cm)	3.5
2.6 Maturity	80-87
2.7 Seed color colour	white
2.8 Fertilizer required	100 kg/ha DAP and 50 kg/ha UREA
2.9 plant height (cm)	128.10
2.10 Length capsule bearing zone (cm)	58.42
2.11 number of capsules / plant	50.03-280
2.12 number of branches/plant	3.34
2.13 number of seeds /capsule	323.10
2.14 thousand Seed weight (gm)	3.05
22.13 Yield (qt/ha)	
> Research field	7-11
> Farmers field	6-8
2.14 oil content (%)	53.7
2.15 crop pest reaction	relatively tolerant insect pests and diseases
3. Year of release 2016	
4. breeder/maintainer	Humera ARC/ TARI



1. Crop name: sesame
- 1.1 variety/accession/name: Setit-3(HuRC-4)
2. Agronomy and morphological characteristics
- 2.1 Adaptation area: low land areas of Tigray and as well as similar agro ecologies of the country
 - Altitude (m.a.s.l) 600-1500
 - Rainfall (mm) 563-888
 - Temperature (C°) 18.8-37.6
- 2.2 Seed rate (kg/ha) row planting (0.8-1.2 kg/ha) and Broad casting 2-3 kg/ha
- 2.3 Distance b/n raws and plants 40 cm x 10 cm b/n rows and plants respectively
- 2.4 Planting date mind june-beginning july
- 2.5 Planting depth (cm) 3.5
- 2.6 Maturity 75-80
- 2.7 Seed color colour white
- 2.8 Fertilizer required 100 kg/ha DAP and 50 kg/ha UREA
- 2.9 plant height (cm) 121.90
- 2.10 Length capsule bearing zone (cm) 57.68
- 2.11 number of capsules / plant 45.50-225
- 2.12 number of branches/plant 2.99
- 2.13 number of seeds /capsule 258.40
- 2.14 thousand Seed weight (gm) 3.02
- 2.13 Yield (qt/ha)
 - Research field 9-12
 - Farmers field 7-9
- 2.14 oil content (%) 54.4
- 2.15 crop pest reaction relatively tolerant insect pests and diseases
3. Year of release 2017
4. breeder/maintainer Humera ARC/ TARI



Table 2. Crop, accession name, released year, oil content and average yield at farmer's field

Commodity	Variety	Released year	Yield at farmers field qt/ha	Oil content %	%Yield advantage /checks
Sesame	Setit-1	2011	7.25	52	
	Humera-1	2011	6.5	54	
	(J-o3)Setit-2	2016	7	53.7	
	(HRC-4)Setit-3	2017	8	54.4	34
Mungbean	(SML)Arkebe	2014	15		30
Okra	(Acc#23793)	2016	150		24.85
Tomato	Bamya-humera (CLN-5915-93-D4) Tekeze-1	2016	370.5		28

Sources: [23]

Table 3. Local varieties at commercial production in northern Ethiopia

Sn	Variety name	Sources	Color	Oil content %	1000swt	Yield qt/ha	Remark
1	Abuseffa	HuARC	White	53	2.99	7.9	Local
2	Kefif	HuARC	White	54	3.31	7.5	Local
3	Gumero	HuARC	White	55	3	7	Local
4	Gojam azele	HuARC	White	53	3.00	7	Local
5	Hirhir	HuARC	White	54	3.2	7	Local

Sources: [26]

3. LOCAL VARIETIES UNDER COMMERCIAL PRODUCTION IN NORTHERN ETHIOPIA

Wijnands et al. [24] reported that the major quality requirements for sesame seed exports are thousand seed weight should be greater than 3 g, 40-50% oil content and pearly-white seed color. Regarding quality of sesame seeds, white seeds with a white to golden color are mainly used in raw form because of their aesthetic value and are mostly priced higher than mixed seeds yellow to dark brown seeds, are generally crushed into oil.

Sesame seed is branded as the Humera, Gonder and Wolega types which are well known in the world market by their white color, sweet taste and aroma. The Humera and Gondar sesame seeds are suitable for bakery and confectionary purposes; on the other hand, the high oil content of the Wolega sesame seed gives a major advantage for edible oil production [25]

4. SUMMARY AND CONCLUSION

Humera Agricultural Research Center (HuARC) is sesame national coordinating center. HuARC has three mandate areas/agro ecologies; low land, high land and mid land in western zone of Tigray, Ethiopia. The center was released seven improved crop varieties from 2011 to 2017 for different purposes; local consumption, oil extraction, export and different industries.

Different crop varieties having different qualities were released sesame; (Setit-1, Setit-2, Setit-3, Humera-1); Mungbean (Arkebe); Tomato (Tekeze-1); Okra (Bamya-humera) for industry, export and other local consumption purposes. Local varieties having different characteristics (farmers' preference, diseases and insect tolerance, white color) and under wide commercial production for export purposes are Abuseffa, Kefif, gumero and Hirhir. The released crop varieties are suitable for low land areas of the country and can be used for commercial production.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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