Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 4, Issue 1, pp: (1-11), Month: January – February 2017, Available at: www.noveltyjournals.com

Sesame *(Sesamum indicum* L.*)*Breeding in Ethiopia

Daniel Endale Gebremichael

Ethiopian Institute of Agricultural Research, Werer Agricultural Research Center, P. O. Box 2003, Addis Ababa, Ethiopia

Abstract: **Sesame (*Sesamum indicum* L.) is an important oil crop in Ethiopia. Despite its importance in the country, there are constraints that need to be addressed through scientific research. The major constraints are lack of improved varieties, low yield of landrace cultivars, indeterminate flowering nature and shattering of capsules at maturity, insects, diseases, heat and drought. Conventional sesame breeding efforts started in the late 1960s, and since then a total of 26 varieties have been developed and released. The use of molecular marker technology in sesame breeding is a new occurrence in Ethiopia. However, there have been efforts on the use of molecular techniques to complement and hasten the conventional sesame breeding. Two PCR-based molecular markers have been developed. Shattering is the number one cause of yield loss in sesame. Hybridization and recently, induced mutation are being employed to find solution to seed shattering.**

Keywords: **Conventional breeding, Indeterminate flowering, Molecular Markers, Seed shatteing, Sesame, *Sesamum indicum.***

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the oldest and most important oil seed crops widely grown in tropical and subtropical regions around the world and is cultivated for its oil-rich seeds, which grow in pods (Weiss, 1983). Sesame is grown in more than seventy countries worldwide. According to FAO (2014) United Republic of Tanzania, India, China, Sudan, Nigeria, Myanmar, Burkina Faso and Ethiopia are the greatest sesame producers, respectively covering 70.88 % of the world production.Sesame is one of the major indigenous oilseeds displaying considerable diversity in Ethiopia (IBC, 2012); annually sesame accounts for about 44 % of the total acreage and 34% of the gross production of the major oilseeds cultivated in the country (Table I).

Sesame, locally called ‘Selit’, is a valuable export crop in Ethiopia. It grows in almost all regions of the country with an altitude of less than 2000m above sea level (Yebiyo, 1985; Adefris et al., 2011) and is a well-established crop in Amhara, Tigray and Oromia regions, respectively. Reports on peasant holdings in sesame showed that 89.95% (2466503.09 tons) of the Ethiopian sesame produce comes from Amhara (48.84%), Tigray (24.52%) and Oromia (16.59%) regions (CSA, 2015). In Ethiopia sesame is grown chiefly for export (more than 95%) and direct consumption (5%) (Annonymous, 2015). The sesame seed is rich in good quality edible oil (up to 60%) and protein (up to 25%) (Brar and Ahuja, 1979). The oil is in demand in the food industry because of its excellent cooking quality, flavor, and stability.In Ethiopia, sesame oil and seed are put to agreat variety of uses.The oil, besides as a cooking medium, is also used for anointing the body. The oil cake which is rich in calcium, is used as feed. The seed is used in the preparation of differet foods (stew called wet, a souce for porridge, snacks, flavoring, sweets and beverages) (Adefris et al., 2011).

The improvement of sesame has lagged behind other crops due to a lack of research, shortage of trained personnel, limited financial support and limited international cooperation. The crop is not dealt with by any of Consultative Group on International Agricultural Research (CGIAR) centers. However, the crop has high agronomic importance as it adapt harsh environments where other oil or food or export crops cannot tolerate (Annonymus, 2007; MoAR et al., 2015). In Ethiopia the mean yield of sesame is very low, Table I. However, there is a great potential to be exploited in sesame production.

International Journal of Novel Research in Life Sciences
Vol. 4, Issue 1, pp: (1-11), Month: January – February 2017, Available at: www.noveltyjournals.com

Many production constraints hindered considerable yield improvement. Indeterminate flowering nature and shattering of capsules at maturity, insects, pests and diseases, heat and drought, among other things are the major factors for low yields of sesame. Breeding adapted and more productive sesame cultivars is recognized as the major option by many experts.

TABLE I. Cultivated area, gross production and average yield of oilseeds cultivated in Ethiopia (Averages of three years CSA data of the 2013–2015 seasons)

Crop	Cultivated area		Total Production		Yield	
	Million ha	% of all oilseeds	Million t	% of the total of oilseeds	t/ha	% of the mean of all oilseeds
Neug	0.27	32.14	0.23	30.26	0.86	12.87
Linseed	0.09	10.71	0.09	11.84	0.99	14.82
Groundnuts	0.07	8.33	0.11	14.47	1.52	22.75
Sunflower	0.01	1.19	0.01	1.32	0.92	13.77
Sesame	0.37	44.05	0.26	34.21	0.71	10.63
Rapeseed	0.03	3.57	0.06	7.89	1.68	25.15
Total	0.84	100	0.76	100	6.68	-

2. BOTANY OF SESAME

Sesame belongs tofamily Pedaliaceae and genus *Sesamum*. The genus *Sesamum* comprises 20 accepted species native to Africa and Asia **(**Bedigian, 2015), but only *S.indicum* has been recognized as a cultivated species in the family. The family pedaliaceae has a superior ovary, usually two-celled, which is completely or partially divided by false septa, each compartment having one to several ovules attached to a central placenta (Demetrios, 1980). Morinaga *et al.* (1929) reported the chromosome number of *S. indicum as* 2n=26. Sesame has an erect growth habit that can reach to a height of 2m depending on the cultivar and growing conditions. Some cultivars are highly branched, while others grow relatively un-branched.The leaves are variable in size and shape, opposite or occasionally alternate. Flowers (Fig. 1) are zygomorphic, solitary, occasionally growing as two or three together, generally pale or rose colored born in the axils of the leaves and on the upper stem or branches. The fruit is deeply grooved capsule (Fig. 2) that contains 50 to 100 or more seeds depending on the environment and cultivar. The seed vary in color. The color of the testa can be black, white, golden, brown or grey, but also dark grey and very dark brown seeds can be found. The weight of 1000 seeds is usually between 2 and 4g. Under optimum conditions the crop produces extensively much branched root system. The growth of sesame is indeterminate, that is the plant continues to produce leaves, flowers and capsules as long as weather permits (Weiss, 1971; Bedigian, 2015).

Cultivated sesame has been described as a self-pollinated species. However, varying degrees of natural crossing to the extent of 2 to 48% has been reported (Daniel and Parzies, 2011). Sesame is an herbaceous annual plant requiring 80-130 days to attain physiological maturity. It requires 25^0C to 27^0C for rapid germination, initial growth and flower formation while temperature below 18^0C after germination restricts growth and high temperature (> 40 ^{0}C) during flowering reduces fertilization. Sesame is very drought resistant/tolerant, due in part to an extensive root system but it requires adequate moisture for germination and early growth. It is extensively susceptible to waterlogging and heavy continuous rains at all stagesof development (Weiss, 1971; Seegeler, 1983; Ashri, 1998).

Fig. 1. Sesame (*Sesamum indicum* L.) flower

Fig. 2. Sesame (*Sesamum indicum* L.) capsule

3. HISTORY OF SESAME IMPROVEMENT

Sesame improvement research in Ethiopia was started in the late l960s by Institute of Agricultural Research (IAR), known at present as the Ethiopian Institute of Agricultural Research (EIAR) at werer agricultural research center (WARC) under irrigation with landraces and exotic germplasms. Sesame breeding research in Ethiopia can be divided into three inter - related periods: 1) First period (late 1960s to 1979) dealt with collection, introduction, characterization and evaluation of sesame germplasm for identifying suitable and best adaptable sesame cultivars for the potential areas, sesame breeding relying entirely upon pure-line and/or mass selection from the local germplasm and introduction. (2) Second period (1980–2007) characterized by the incorporation of crossing program into the already pre-existing breeding methods. Although sesame research in Ethiopia actually began in the late 1960s the work was not systematized until 1980. As of 1980, IAR has devised a new approach to solve the problems in the field of sesame research by aggregating the highly diffused manpower into a team. Consequently the experiments on sesame started to be executed under three agro-ecological zones (irrigated, high rainfall and low rainfall) of Ethiopia to meet the requirements of specific regions. The crossing program was initiated in 1983 to generate new working materials that were designed to fit specific objectives, such as, white seed coat, earliness, non–shattering, high yield and bacterial blight resistance. In spite of high efforts made, breeding for indehiscent types was a complete failure (Bulcha, 1988; Elias, 1988; Hiruye et al., 1989; WARC, 2008; Yebiyo, 1985). 3). Third period (2008 to present) marked by the initiation of molecular approaches including analyses of molecular genetic diversity, development of molecular markers and initiation of induced mutation techniques particularly for pod shattering (Daniel and Parzies, 2011; Admas, 2013, Mohammed et al., 2015a; Dagmawi, et al., 2015; Mohammed and Firew, 2015a; WARC, 2015).

SESAME BREEDING OBJECTIVES/GOALS:

Sesame is an important oil crop in Ethiopia in terms of both area coverage and production (CSA, 2015). The objective of sesame breeding in Ethiopia is to develop this potential by creating cultivars which meet the demands of the sesame growers, processor, and consumer. According to the sesame project document developed by Ethiopian sesame breeders in 2007, a list of breeding goals are compiled. These, classified according to needs of differing stakeholders, for growers– higher yields, partial/non-shattering, determinate flowering, insects (webworm, gall midge, termites, seed bug etc..) and diseasesresistance (bacterial blight,phyllody, Fusarium wilt, Powdery mildew etc.) and environmental stress- tolerance (resistant/tolerant to drought, heat); for processers – more uniform maturity and for the consumer– improved nutritional seed properties with seed of preferred shape, size, texture, color and flavor.

Shattering is the most important yield limiting factor of sesame in Ethiopia. Shattering of capsuleat maturity leads to poor harvest index and sometimes when it is combined with shortage of labor during harvesting lead to complete loss of yield. In Ethiopia, cultivated sesame cultivars have indeterminate flowering habit which will continue flowering as long as moisture and nutrients are available. As the flowering continues, the early capsules dry down, open and lose their seed. This plant character makes it difficult its harvest by combine. Because of this problem, in Ethiopia, it is grown and harvested manually (Tadele, 2005; Adefris et al., 2011; WARC, 2014; MoARD et al., 2015). Therefore, the development of productive non- shattering cultivars is critical for cultivation of sesame in more intensive agriculture with mechanized harvesting. Disease resistance, especially to bacterial blight ,has been of some concern as a sesame breeding objective particularly to address humid and high rainfall sesame growing areas of Ethiopia. Hence, the bacterial blight resistance breeding objective is due mainly to the little variation in the existing germplasm evidenced by, most of the accessions exhibiting high severity and susceptible reaction, while the relatively better genotypes show only quantitative resistance/tolerance. Bacterial blight is a destructive disease and reported to cause complete loss of crop particularly under high rainfall conditions in Ethiopia (Tadele, 2005; Wijnands et al., 2007; MoARD et al., 2015). The major beneficiaries of the sesame breeding programme are the subsistence and large scale sesame growing Ethiopian farmers and their families. Cooperatives and unions, oil mills and confectionary food processing industries which produce their products targeted to both the domestic and export market, exporters and traders involved in oilseed cleaning, packaging and export and consumers (local consumers of sesame oil and seed) would also be beneficiaries of the improvement programme.

BREEDING STRATEGY AND INSTITUTIONAL SETUP:

The success of the breeding strategies of sesame relies heavily on the genetic diversity of the crop (Ashir, 1998; Ganesh and Thangavelu, 1995; Daniel, 2008). Current strategic directions of thesesame breeding programmeare: (i) development of cultivars adapted to specific agro climatic regions (ii) increase market value in terms of goodquality components; and (iii) expansion of sesame into non-traditional areas. Although there is no strong breeding programs in all regions around the country, currently this crop has two major groups all over the country with the mandate to work with sesame: Humera Agricultural Research Center and Werer Agricultural Research Center, with national mandates. However, small groups are also found atPawe Agricultural Research Center, Assosa Agricultural Research Center, Bako Agricultural Research Center, Sirinka Agricultural Resesearch Center, Afar Pastoral and Agro-pastoral Research Institute (APARI), Gode Agricultural Research Center, Southern Agricultural Research Institute, Haromaya University andGonder Agricultural Research Centerwith the mandate to work on sesame (EIAR, 2016).

Werer agricultural research center, who has been coordinating sesame research at national level since late 1960s, transferred the responsibility to Humera agricultural research center in July, 2011. Werer agricultural research center made tremendous effort to educate and train sesame researchers and has been excellent to provide new breeders with improved breeding lines, germplasms as well as additional opportunities for training, including hands-on exercises on breeding techniques (WARC, 2011; WARC, 2012). Humera agricultural research center currently houses the national sesame improvement project interms of responsibilities for the overall national coordination, as well as the development and execution of a country-wide sesame research projects. Under the umbrella of this institutional framework, the activities particularly multi-location variety trials of the sesame breeding programmes are carried out at various federal and regional research centers and testing sites, higher learning institutes and on farmers' fields.

SESAME GERMPLASMS:

Werer agricultural research center (WARC) commenced a genetic resources activity in order to strengthen and enrich sesame improvement program and to make invaluable genetic material available to scientists all over the country. The breeding department collects, evaluates, maintains, conserves, documents, and exchanges germplasm of sesame for present and future utilization. The germplasm collection missions are mostly launched in collaboration with a Plant Genetic Resources Center, Ethiopia (PGRC/E), known at present as the Ethiopian Biodiversity Institute (EBI). The germplasms were collected from northern, eastern, western, central and southern parts of the country covering nearly seven adminstrative regions. However, only the accessable parts of the regions were covered and the collection team lacked experienced breeders and taxonomists. The total number of accessions is now 1400. This is probably the largest collection of germplasm of sesame crop assembled at one place in Ethiopia. However, we still consider that this total is rather small compared with what is yet uncollected. The germplasm collections have been characterized for agro-morphological characters at Werer agricultural research center. Results of the characterization have been documented to facilitate selections and evaluations of genotypes with a combination of desirable traits. Documented germplasms in WARC do not have an internationally known number and currently no work is underway to organize germplasm collections systematically (Elias, 1988; Hiruy et al., 1989; Tadele, 2005; MWRC, 1986, 1987; WARC, 2003, 2004, 2005, 2015; Daniel, 2008). The ranges of variation in important phenologic, morphological and agronomic traits of sesame obtained based on values reported in a different studies is summarized in Table II. Generally, sesame germplasms exhibits broad diversity in most of the agronomic traits .

TABLE II. Ranges for important phonological and agronomic traits of sesame germplasms collected from different parts of Ethiopia (Source: Yirgalem et al., 2013; Desawi et al., 2014)

Traits	Minimum	Maximum
Plant height (cm)	54.2	163.9
Capsule length (cm)	1.5	3.62
Height to first capsule (cm)	10.4	108.2
Number of capsule per plant	10	102
Days to maturity	82	113
Capsule filling period (days)	17	80
Number of primary branches/plant	1	8.3
Internode length (cm)	2.5	9.4
Number of seeds/capsule	25	87
1000 seed weight (g)	1.3	4.1
Days to 50% flowering	29	66
Oil content (%)	34.6	55.5
Seed yield/ha (kg/ha)	134.64	1361

BREEDING METHODOLOGY AND MAJOR ACHIEVEMENTS:

Ethiopian sesame breeders have come to rely on breeding methods involving the use of collection, introduction, selection (mass and pureline), hybridization (followed by pedigree and bulk method of breeding) and recently induced mutation. Sesame is rich in genetic variability (Daniel and Parzies, 2011). The general methodology employed in sesame breeding is depicted by the variety development process flow chart Fig. 3. Since sesame is indigenous oilseed displaying considerable diversity in Ethiopia (IBC, 2012), the collection work becomes very important in the over all improvement programme for the crop. The collection has been carried out with the objective of enriching the genetic variability of the crop through breeding programme. A number of sesame germplasms were introduced from different part of the world. The suitable ones adapted to the specific region most successfully are released after careful evaluation. Selection (Mass and pureline) has also proved successful in the past.The major limitation to the selection method of developing varieties has been a lack of sufficient genetic variability, as selection had to rely either an existing variability in the germplasms resulting from natural out-crossing or natural mutations. Hybridization is the most frequently used technique in conventional sesame breeding (Demetrios, 1980). However, the variability created through artificial cross pollination is untapped resource in Ethiopia and is expected to be the prime means of sesame cultivar improvement in the future (Daniel, 2008). A crossing program was started at werer agricultural research center since 1983 with the main aim to incorporate high seed and oil yield, drought and disease resistance (bacterial blight), partial-shattering and determinate flowering characters. Subsequent segregating populations were handled using pedigree and bulk methods of breeding (MWRC, 1983, 1984, 1985; WARC, 2006; Tadele, 2005). Induced mutation program using chemical mutagens is in progress for generation of variability for some important traits such as shattering resistance since sufficient variability in the existing germplasm is lacking (WARC, 2015).

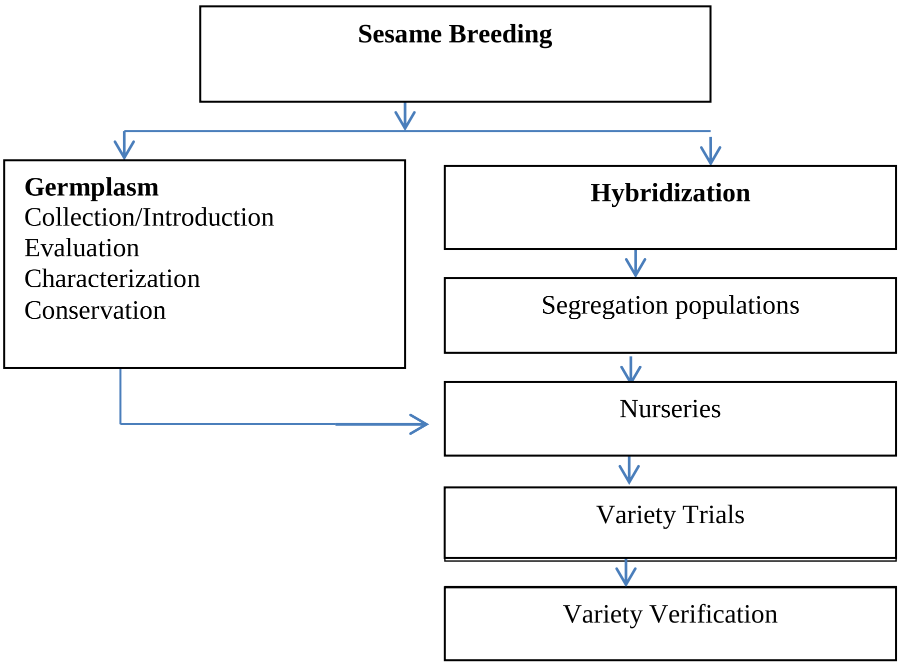

Fig. 3. Variety development process in sesame breeding

The next stage is the nursery for initial evaluations of selected genotypes from the collection, introduction, selection and hybridization followed by a serious of yield trials including preliminary, pre-national, national variety trials. At the last stage of the process, promising genotypes selected as candidate variety based on their performance in the various variety trials are entered in to variety verification trials for evaluation by the national variety release committee. Variety development process in sesame breeding depicted in Fig. 3. Since the initiation of the improvement work in the late 1960s, a total of 10 varieties of sesame have been released from Werer Agricultural Research Center from 1976 up to 2000 (Table III) and two varieties each from Gode ('Barsan' and 'Lidan'), Agricultural Research Centers and Haromaya (BaHa-necho and BaHa-zeyit) university, and one variety each from, Assosa ('Benishangul-1'), Pawe ('Dangure') and

Gonder (‘Gonder-1’) and three varieties each from Humera (‘Humera-1’, ‘Setit-1’, ‘Setit-2’), Bako (‘Obsa, ‘Dicho' and 'Chalsa’) and Sirinka (‘Ahadu’, ‘Borkena’ and ACC 00047) Agricultural Research Centers from 2007 to 2016 (Table IV). Of these, six varieties (‘T-85’, ‘Kelafo-74’, ‘E’, ‘S’, ‘Mehado-80’ and ‘Abasena’) resulted from pureline method of selection, two varieties (‘Argene’ and ‘Ahadu’) were evolved through hybridization and the rest eighteen from mass selection. Eight of twenty six improved sesame varieties grown in Ethiopia originated as introductions from different countries of the world. Two varieties (Humera-1 and Setit-1) are widely grown by farmers in Humera and Metema areas, whereas Adi and Abasena, are grown in irrigated and in areas of optimum rainfall, respectively. Generally the improved sesame varieties mean yields ranging 3 to 10qt/ha under rainfed and 10 to 24 qt/ha under irrigation.

TABLE III. Improved varieties of sesame released by Werer Agricultural Research Center in Ethiopia from 1976 to 2000

Varieties	**Year of release**	**Yield (qt/ha)**			**Seed color**	**Oil (%)**	**Maturity date**	**Adaptation Areas**
		Irrigated	**HRF**	**MRF**				
T-85	1976	10	7	5	Dull white	42.23-45.9	100-115	Humera plains
Kelafo 74	1976	12	6	3	Light brown	42.07-46.1	110-120	Gode
E	1978	14	7	3	Dull white	42.23-46.95	88-120	Ittigated areas awash valley
S	1978	12	7	4	Mixed(blak, light brown)	40.8-46.70	100-120	Irrigated areas awash valley
Mehado-80	1989	17	6	4	Grey	41.5-44.53	100-110	Irrigated areas Awash valley
Abasena	1990	14	9	4	White	40.6-48.7	103-120	High rainfall areas (Gambella, Pawe , Didesa)
Argene	1993	18.06	-	-	Mixed(white, deep brown, light brown)	42.87-48.29	88-98.67	MelkaWerer and Dubti
Adi	1993	17.3	-	-	White	40.20-57.7	85-91	Middle Awash (MelkaWerer)
Serkamo	1993	18.2	-	-	Mixed(white, grey, brown)	42.63-50.9	103	Melkawerer and Dubte
Tate	2000	18	-	6.5	Light grey	47.48-48.71	111-115	Low rainfall areas (Miesso, Babile)

*Note: 1 quintal (qt) = 100kg   * HRF = high rainfall areas   * MRF = marginal rainfall areas*

Source: Werer Agricultural Research Center

Table IV. Improved varieties of sesame released by Sirinka, Bako, Humera,Gode, Pawe, Assosa, Gonder Agricultural Research Centers and Haromaya University in Ethiopia from 2007 to 2016

Varieties	Year of release	Yield qt/ha		Seed color	Oil (%)	Maturity date	Adaptation Areas
		Irrigated	Rainfall				
Ahadu	2007	-	7-10	Brown	49-51	105-115	Moisture stress areas of wello
Borkena	2007	-	6-8	Brown	47-48	105-120	Moisture stress areas of wello
Obsa	2010	-	10.69	White –tan	51.55	120-137	Bako, Deddesa, Gutin and similar agro-ecologies

International Journal of Novel Research in Life Sciences
Vol. 4, Issue 1, pp: (1-11), Month: January – February 2017, Available at: www.noveltyjournals.com

Dicho	2010	-	10.63	White	53.8	131-142	Bako, Deddesa, Gutin and similar agro-ecologies
Humera-1	2011	-	5.9-9	White	54-56	90-110	Dansha, Tacharmacho
Setit-1	2011	20-24	6.20-10	White	52-54	80-90	Kafta-Humera, Sheraro
Barsan	2010	9.6	-	Brown	45.9	80-90	Somali region (Gode, Kelafo)
Lidan	2010	10.8	-	Brown	46.9	80-90	Somali region (Gode, Kelafo)
ACC 00047	2013	-	7-8	white	50.4	105-120	Moisture stress areas of wello
Chalsa	2013	-	10.5-12	Light white	51	95-120	Bako, Deddesa, Gutin and similar agro-ecologies
Dangur	2015	-	7.5	Grey	56.7	124	Pawe, Bullen, Guba, DangurMandura and areas with similar agro-ecology
BaHa-zeyit	2016	-	13	Light grey	56	113-134	Gursum, Babile, Bisidimo and similar agro-ecologies
BaHa-necho	2016	-	12	white	52	114-129	Gursum, Babile, Bisidimo and similar agro-ecologies
Benishangul-1	2016	-	8-10	white	54	90-115	Pawe and Assosa
Gonder-1	2016	-	5-9	white	50	101	Low land area of north western Ethiopia
Setit-2	2016	-	9.3	white	53.77	80-87	Kafta-Humera, Sheraro

Source: MoARD, crop variety register book 2007- 2016 *Note:*1 quintal (qt) = 100kg

NEW AREAS OF WORK IN SESAME:

Genetic diversity of Ethiopian sesame have been studied using morphological and molecular markers. Agro-morphological marker has been a primary tool to estimate genetic differences among Ethiopian sesame genotypes (Sileshi, 2008, Gideyet al., 2012; Yirgalem et al., 2013; Desawi et al., 2014, Mohammed and Firew, 2015b; Mohammed et al., 2015b). Molecular markers have several uses including genome mapping, DNA fingerprinting and study of genetic diversity. In recent years, the use of molecular markers is showing significant progress in plant breeding especially in marker assisted selection (Mohan et al., 1997; Jonah et al., 2011). Molecular markers are identifiable DNA sequences, found at specific locations of the genome, and transmitted from one generation to the next. They are relatively simple to detect, abundant throughout the genome, completely independent of environmental conditions, reflect the actual level of genetic difference existing between genotypes and can be detected at virtually any stage of plant development. Therefore, molecular markers are widely considered as powerful tools in analyzing genetic diversity (Karp and Edwards, 1995; Karp et al., 1997 and Staub et al., 1997). Information on the use of molecular markers for the characterization of genetic diversity in Ethiopian sesame is limited. Molecular markers such as Simple sequence repeat (SSR) markers (Daniel and Parzies, 2011), Inter simple sequence repeat (ISSR) markers (Admas, 2013, Mohammed et al., 2015a and Dagmawi et al., 2015) and Random Amplified Polymorphic DNA (RAPD) markers (Mohammed and Firew, 2015b) were applied to Ethiopian sesame genetic diversity study.Generally, the use of molecular marker technology in sesame breeding is a new occurrence. However, there have been efforts on the use of molecular techniques to complement and hasten the conventional sesame breeding. Simple sequence repeat markers named as : Si-ssr8910 and Si-ssr8920 were developed from publicly available Expressed Sequence Tags (ESTs) database. The SSR markers were polymorphic and have been used to study the genetic variability of 50 sesame germplasms/varieties from Ethiopia (Daniel, 2008).

Genetic diversity analysis through morphological and molecular markers revealed that Ethiopian sesame landraces have a very high genetic diversity. Therefore *in situ* conservation of sesame genetic resources should be considered. Preservation of the indigenous sesame landraces has a particular significance in the breeding program as characters needed by sesame breeders to solve acute national problems may exist in these materials. The landraces have a considerable amount and distribution of genetic diversity. Hence they might be important sources of genes for desirable traits in sesame breeding (Desawi et al., 2014; Daniel and Parzies, 2011).

4. CONCLUSION

Sesame has been under investigation in Ethiopia since late 1960s . The future of sesame production in Ethiopia is very promising due to its economic value and export potential, which has made it a favorable crop to farmers. Improvement of the sesame crop can beachieved by various methods such asconventional and molecular breeding methods to obtain outstanding genotypes/varieties.Breeding efforts so far made in the country have not resulted in any substantial and significant breakthroughs in the per hectare yields of seed. Data so far available from yield trials carried out by researchers at research and farmers fields clearly show that none of the high yielding varieties available till date are capable of giving more than 2400 kg/ha under conditions of best management, optimum levels of inputs and ideal agro-climatic conditions (Table III and Table IV). The future of sesame as a commercial crop in its traditional strongholds and its expansion into non- traditional areas largely depend on the extent of progress we achieve in overcoming the present yield barriers. Unfortunately, the available germplasm materials have not yet been fully and systematically exploited in sesame improvement programmes.

Until recently hybridization has played little or no role in the development of new varieties. This is obvious from the fact that 24 out of 26 varieties bred so far are products of selections from germplasm materials. Although development of varieties with multiple resistance forms an important breeding objective there has been no worthwhile progress in this direction. This is a serious gap, which needs to be filled rapidly in order to bring a major impact on sesame production in the country. Apart from intensifying search for durable and stable sources of resistance/tolerance to major pests and diseases in the germplasm of cultivated species, the wild species in the genus *Sesamum* which posses abundant variability for resistance to numerous pests, diseases and drought should be effectively tapped in crosses with cultivated species (Brar and Ahuja, 1979, Joshi, 1961; Kolte, 1985; Nayar and Mehra, 1970; Uzo and Adedzwa, 1985; Weiss, 1971). Ethiopia is so latetobegan sesame research work and short of exchange and cooperation with other research centers in the world. Conventional and molecular breeding methods are complementary to each other for improving sesame. However, none of the improvement strategies alone is totally perfect. Sesame breeding objectives can be achieved by devising breeding programs with specific targets. Application of molecular breeding along with conventional breeding methods will be a useful approach for breeding superior varieties in a short time.

Sesame is a self-fertilizing crop. The hermaphroditic flowers easily causes self-fertilization, with 9.1% to 96.4% cross pollination (Daniel and Parzies, 2011) in the field. As a result, the sesame landraces have a high level of heterogeneity and hetrozygocity and more advanced cultivars are difficult to keep true to type by farmers who propagate their own seeds. Therefore, new technologies like adequate isolation of the different varieties in the seed production should be introduced to the farmers to implement a sustainable way of maintaining and propagating their preferred cultivars. Twenty four released sesame varieties in Ethiopia were the product of selection and two varieties were evolved through hybridization. A major constraint in this approach was the lack of sufficient genetic variation within the existing germplasm collections, especially for traits such as resistance to different diseases and seed retention. This is where mutation techniques could offer a possible solution. Traditional breeding method must also be conducted systematically to develop non dehiscent sesame varieties.

REFERENCES

[1] Adefris T, Tadele A, and Tesfaye M. 2011. Sesame Cultivation and Use in Ethiopia. In: Bedigian D (ed) Sesame: the genus *Sesamum*. Medicinal and Aromatic Plants-Industrial Profiles , CRC Press, Tayler& Francis Group, Boca Raton. Pp. 298-318.

[2] Admas A, Yohannes P, Kassahun T. 2013. Genetic Distance of Sesame (*Sesamumindicum* L.) Cultivars and Varieties from Northwestern Ethiopia using Inter Simple Sequence Repeat Markers. East Afr. J. Sci. 7(1).31-40.

[3] Anonymous. 2007. Development and promotion of lowland oilcrops technologies for market oriented production : Detailed Project document for lowland oil crops. Ethiopian Institute of Agricultural Research, AddisAbeba, Ethiopia.

[4] Ashri A. 1998. Sesame Breeding. In: Janick J (eds) Plant Breeding Reviews. John Wiley & Sons. Inc Publishers, Oxford, UK.pp 179-228.

[5] Bedigian D. 2015. Systematics and evolution in *Sesamum* L. (Pedaliaceae), part 1: Evidence regarding the origin of sesame and its closest relatives. Journal of Plant Taxonomy and Geography. 70: 1–42.

[6] Brar GS and Ahuja KL. 1979. Sesame: its culture, genetics, breeding and biochemistry. Pp.245-303 in Annu. Rev. of Plant Sci (C.P. Malik, ed.). Kalyani publishers, New Delhi.

[7] BulchaWeyessa. 1988. Present research progress and future research needs of lowland oil crops. P.274-285. In :procedding of the 19th National Crop Improvement Conference, Addis Abeba, Ethiopia, 22-26 April 1986. Institute of Agricultural Research, Addis Ababa, Ethiopia.

[8] CSA (Central Statistic Authority). 2013. Ethiopian agricultural sample enumeration : Report on the primary results of area, production and yield of temporary crops of private peasant holdings in meher season, Addis Ababa, Ethiopia.

[9] CSA (Central Statistic Authority). 2014. Ethiopian agricultural sample enumeration : Report on the primary results of area, production and yield of temporary crops of private peasant holdings in meher season, Addis Ababa, Ethiopia.

[10] CSA (Central Statistic Authority). 2015. Ethiopian agricultural sample enumeration : Report on the primary results of area, production and yield of temporary crops of private peasant holdings in meher season, Addis Ababa, Ethiopia.

[11] Dagmawi T, Kassahun T and Endashaw B. 2015. Genetic diversity of sesame germplasm collection (*Sesamumindicum* L.) : implication for conservation, improvement and use. Int. J. for Biotechnol. Mol. Biol. Res. 6(2).7-18.

[12] Daniel EG. 2008. Investigation of the genetic variability among landraces of sesame (*Sesamumindicum* L.) from Ethiopia using simple sequence repeat markers. Master thesis, University of Hohenheim, Stuttgart, Germany.

[13] Daniel EG and Parzies HK. 2011. Genetic variability among landraces of sesame in Ethiopia. Afr. Crop Sci. J. 19 (1): 1-13.

[14] Demetrios MY. 1980. Sesame. In: Walter RF and Henry HH (ed) Hybridization of Crop Plants. American Society of Agronomy and Crop Science Society of America, Madison, Wisconsin, USA. Pp. 549-561.

[15] Desawi HT, Sentayehu AK and Daniel EG. 2014. Assessment of Genetic Variability, Genetic Advance, Correlation and Path Analysis for Morphological Traits in Sesame Genotypes. Asian. J .Agri. Res. 8(4):181-194.

[16] Elias Urage. 1988. The current status and future trends of sesame research in Ethiopia. In: Omar A (ed.) Oilcrops: Sesame and Sunflower Subnetworks. Proceedings of the Joint Workshop held at Nairobi, Kenya. IDRC, Ottawa, Canada. Pp.103-105.

[17] Ethiopian Institute of Agricultural Research (EIAR). 2016. National Sesame Research Strategy: Fifteen Years (2016-2030). Addis Ababa, Ethiopia.

[18] FAO. 2014. FAOstatDatabases. http://faostat.fao.org.

[19] Ganesh SK and Thangavelu S. 1995. Genetic divergence in sesame (*Sesamumindicum*L.). Madras Agric. J. 82: 263-265.

[20] Gidey YT, Kebede SA and Gashawbeza GT. 2012. Extent and pattern of Genetic Diversity for Morpho-agronomic Traits in Ethiopian Sesame Landraces (*Sesamumindicum* L.). Asian J.Agri. Res. 6(3).118-128.

[21] Hiruy B, Bulcha W and Elias U. 1989. Progress in sesame research in Ethiopia. In: Omar A (ed.) Oilcrops: Sesame and Sunflower Subnetworks. Proceedings of the Joint Workshop held in Cairo, Egypt . IDRC, Ottawa, Canada. Pp.13-16.

[22] Institute of Biodiversity Conservation (IBC). 2012. Ethiopia: Third country report on the state of plant genetic resources for food and agriculture. Addis Ababa, Ethiopia.

[23] Jonah PM, Bello LL, Lucky O, Midau A and Moruppa SM. 2011. Review : The Importance of Molecular Markers in Plant Breeding Programmes. Global Journal of Science Frontier Research Volume 11 Issue 5 Version 1.0

[24] Joshi AB. 1961. *Sesamum*. Indian Central Oilseeds Committee. Hyderabad, India.

[25] Karp A and Edwards KJ. 1995. Molecular techniques in the analysis of the extent and distribution of genetic diversity. IPGRI Work-shop on Molecular Genetic Tools in Plant Genetic Resources. IPGRI, Rome, Italy.

[26] Karp A, Kresovich S, Bhat KV, Ayada WG and Hodgkin T. 1997. Molecular tools in plant genetic resources conservation: a guide to the technologies. IPGRI technical bulletin no 2. International Plant Genetic Resources Institute, Rome, Italy.

[27] Kolte SJ. 1985. Diseases of Annual Edible Oilseed Crops. Vol.11. Rapeseed Mustard and Sesame Diseases. CRC Press, Boca Raton, Florida, USA. Pp.135.

[28] MoARD (Ministry of Agriculture and Rural Development). 2007-2016. Crop Variety Register Book. Animal and Plant health Regulatory Directorate. Addis Abeba, Ethiopia.

[29] MoARD, EIAR, MOT and ATA. 2015. Sesame Value Chain Development Strategy : Working Document 2015-2019. Addis Ababa, Ethiopia.

[30] Mohammed A and Firew M. 2015a. Assessment of Genetic Diversity in Ethiopian Sesame (*Sesamumindicum* L.) Germplasm using Random Amplified Polymorphic DNA (RAPD) Markers. Journal of Advances in Agriculture. 5(2).

[31] Mohammed A and Firew M. 2015b. Assesment of Genetic Variability and Character Association in Ethiopian low-altitude Sesame (*Sesamumindicum* L.) Genotypes. JABE. 2(3).

[32] Mohammed A, Firew M, Amsalu A and Mandefro N. 2015a. Assessment of Genetic Diversity in Ethiopian Sesame (*Sesamumindicum* L.) Germplasm Using ISSR Markers. BBJ. 8(4): 1-13.

[33] Mohammed A, Firew M, Amsalu A and Mandefro N. 2015b. Genetic Variability and Association of Traits in Midaltitude Sesame (*Sesamumindicum* L.) Germplasm of Ethiopia. AJEA. 9(3): 1-14.

[34] Mohan M, Nair S, Bhagwat A, KrishanTG,Yano M, Bhatia CR and Sasaki T. 1997. Genome mapping, molecular markers and marker assisted selection in crop plants. Molecular Breeding. 3: 87-103.

[35] Morinaga T, Fukushima E, Kano T, Maruyama Y and Yamasaki Y. 1929. Chromosome numbers of cultivated plants II. Shokobut-sugakuZasshi. Botanical Magazine of Tokyo. 43: 589–594.

[36] MWRC (MelkaWerer Research Center).1983. Progress report. Lowland oilcrops Research Division, MelkaWerer, Ethiopia.

[37] MWRC (MelkaWerer Research Center).1984. Progress report. Lowland oilcrops Research Division, MelkaWerer, Ethiopia.

[38] MWRC (MelkaWerer Research Center).1985. Progress report. Lowland Oilcrops Research Division, MelkaWerer, Ethiopia.

[39] MWRC (MelkaWerer Research Center).1986. Progress report. Lowland oilcrops Research Division, MelkaWerer, Ethiopia.

[40] MWRC (MelkaWerer Research Center).1987. Progress report. Lowland Oilcrops Research Division, MelkaWerer, Ethiopia.

International Journal of Novel Research in Life Sciences
Vol. 4, Issue 1, pp: (1-11), Month: January – February 2017, Available at: www.noveltyjournals.com

[41] Nayar NM and Mehra KL. 1970. Sesame : its use , botany, cytogenetics and origin. Econ. Bot. 24:20-31.

[42] Seegeler CJP. 1983. Oil Plants in Ethiopia, their Taxonomy and Agricultural Significance. Agricultural research report 921. Wageningen, the Netherlands: Pudoc.

[43] Sileshi AM. 2008. Genetic Divergence and Correlation Study in Sesame *(Sesamumindicum L.)* Genotypes. M.Sc thesis. Addis Ababa University, Ethiopia.

[44] Staub JE, Box J, Meglic V, Horejsi T and McCreight JD. 1997. Comparison of isozyme and random amplified polymorphic DNA data for determining intraspecific variation in *Cucumis*. Genet. Res. Crop Evol. 44: 257-269.

[45] Tadele Amde. 2005. Sesame (*Sesamumindicum* L.) Research in Ethiopia: A Review of Past Work and Potential and Future Prospects. In :Martínez JF (ed) Sesame and Safflower Newsletter 20. IAS, Córdoba, Spain.

[46] Uzo JO and Adedzwa DK. 1985. A search for drought resistance in the wild relatives of the cultivated sesame (*Sesamumindicum* L.). In : A. Ashir (ed.), Sesame and Safflower : Status and Potentials. FAO Plant Production and Protection Paper 66, Rome. pp.163-165

[47] WARC (Werer Agricultural Research Center). 2003. Progress report. Lowland oilcrops Research Division, Werer, Ethiopia.

[48] WARC (Werer Agricultural Research Center). 2004. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[49] WARC (Werer Agricultural Research Center). 2005. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[50] WARC (Werer Agricultural Research Center). 2006. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia

[51] WARC (Werer Agricultural Research Center). 2008. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[52] WARC (Werer Agricultural Research Center). 2011. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[53] WARC (Werer Agricultural Research Center). 2012. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[54] WARC (Werer Agricultural Research Center). 2014. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[55] WARC (Werer Agricultural Research Center). 2015. Progress report. Lowland Oilcrops Research Division, Werer, Ethiopia.

[56] Weiss EA. 1971. Castor, Sesame and Safflower. Leonard Hill, London, UK. Pp. 311-525.

[57] Weiss EA. 1983. Sesame. In Oilseed Crops. Longman, London. Pp. 282-340.

[58] Werer Agricultural Research Center. 2009. Sesame production manual prepared for training. Werer Agricultural Research Center, Werer, Ethiopia.

[59] Wijnands J, Biersteker J, Hiel R. 2007. Oilseeds Business Opportunities in Ethiopia. The Hague.

[60] Yebiyo Woldemariam.1985. Sesame Adaptation test in different agro ecological zones of Ethiopia. In: Abbas Omran (ed.) Oil crops : Sesame and Safflower. Proceedings of the Second Oil Crops Network Workshop held in Hyderabad, India. IDRC, Canada. Pp.162-167.

[61] Yirgalem TG, Sentayehu AK and Geremew TG. 2013.Assessment of Genetic Variability, Genetic Advance, Correlation and Path Analysis for Morphological Traits in Sesame Genotypes. Int. J. Plant Breed. Genet. 19(1):21