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Progress of Soybean [Glycine max (L.) Merrill] Breeding and Genetics Research in Ethiopia: A Review

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Abstract
Ethiopia the second largest population in Africa and is one of the five fastest growing economies in the world. The global population is expected to increase by roughly 20% in the next 20 years. Agro-industries in Ethiopia like Jimma, Hawasa ,Mekele, Kombolcha and the like needs providing tax exemptions for oil processing plants to use the close destination opportunity to the European markets for contributing for foreign currency reserve.Since there is huge potential for soybean production in the country, mechanized soybean farming should be introduced;machines should extensively use in sowing and harvesting so that that the yield of soybean has been improved.Model cultural techniques are studied and practiced in various soybean so that varieties should used according to recommendation. This implies an incomplete value-chain development. Availability of sufficient genetic variability has been the major limitations of soybean breeding in the country. To overcome the problem introduction of germplasms from various sources and > 1000 germplasm has been introduced in the last 4 years. In addition, there has been considerable effort to improve the local capacity to enhance the genetic variability through hybridization and selecting recombinant inbred lines (RILs) from the segregating populations. Consequently, crossing and evaluation of segregating populations (F_2-F_4) are being done every year. Modified single seed descent was identified as the best procedure to evaluate segregating populations and select transgressive segregants. The first 200 RILs were developed by Jimma Agricultural Research Centre and evaluated at different stages of variety trials and some of these materials are in the national and Pre-national variety trials. Generally, strategies' that enhance the productive potentials of the crops that make the crop attractive choice of smallholder farmers for production, large scale plantation and agro- industries needs to be designed to help farmers exploit the multiple benefits of the crop. Thus, the objectives of this review paper are to discuss the genetic resources of with the examples taken from the Ethiopian context.
Keywords: Ago-industry, Cost cutting technology, mal-nutrition, RILs, transgressive sergeants

1. INTRODUCTION

Soybean the family Leguminosae, subfamily Papilionoideae, and the genus Glycine*L.*Historical and geographical evidence suggests that soybean is originated in China and has been cultivated (>500) years (Qiu*et al*., 1999) .*G. soja* is the progenitor of the cultivated soybean (*Glycine max* (L.) Merrill). Chromosomes number 2n=4x=40 (both the cultivated and the wild soybean). Both the cultivated and wild soybean is derived from GG genome (chromosome set). The cultivated and wild soybeans are crossable and F1s are fertile. This indicates that there is no isolation between the cultivated soybean and the wild soybean that they are close relatives (Li-Juan Qiu and Ru-Zhen Chang). From molecular data evidence point of view, within the wild species of subgenus *Glycine*, considerable differences in repeat size occur in several species, but no variation of ribosomal DNA-RFLP has been found in >40 accessions of the two species between the cultivated soybean and its wildprogenitor, *G. soja* (Doyle and Beachy, 1985). Both *G. max* and *G. soja*are close in their genome structure, detected by simple repetitive sequences (Yanagisawa *et al*., 1994). The subgenus *Soja*, comprised of two highly variable species (*G.ax* and *G. soja*), was confirmed by RFLP of chloroplast variation (Shoemaker *et al*., 1986; Close *et al*., 1989; Abe *et al*., 1999), genomic DNA variation (Keim *et al*., 1989), random amplified polymorphic DNA data (Chen and Nelson, 2004) and single nucleotide polymorphisms of *GmHs1pro-1* (Yuan *et al*., 2008), as well as by SSR data (Powell *et al*., 1996). Soybean is strictly self-pollinated with less 1% outcrossing. In a 2-year study with two cultivars using flower color, cross-pollination rates varied from 0.03% to as high as 6.2 % (Ray *et al.* 2003).

Soybean production begins only recently in Africa, during the second half of 20^{th} century is believed introduced to Ethiopia in the 1950's. The variety research is started in the 1970's. Most important oil and pulse crop.

In Ethiopia, work on soybean is at Ethiopian Institutes of Agricultural Research (EIAR, Addis Ababa), with the pulse, oils and fiber commodities division during 1950's. having this research efforts twenty soybean genotypes were released as the direct introduction from different sources (See table 12). The leading oil crop, next to palm with over 250 million metric ton production in 2013 (FAO, 2014). Rich sources of protein 38-46% and 18-20% oil. Soybean containing 2.5 times the protein contents of wheat and four times the protein contents of maize. This is especially true for vegetable soybean, due to its high protein, dietary fiber, health promoting phytochemicals and easy cooking; it is an attractive crop for alleviating protein malnutrition. Because it also contains cholesterol free fat it is an excellent vehicle for the absorption of vitamin A. Soya protein isolates can also be used in coffee creamers, formulates for children allergic to milk protein or showing lactase intolerance as well as famine relief and nutritional for infants and children at weaning in developing countries (Lusas and Rhee, 1995). It is also a short growth duration crop. From sowing to harvest takes about 65-75 days. Furthermore, the green or dried forage from the crop after the harvest can be fed to cattle or ploughed under as a green manure to enrich the soil. In the USA, the Federal Food and Drug Administration allows foods containing 5g of soybean protein per serving to be labeled as reducing heart disease (Ash *et al*., 2006). Medicinal value because of the amino acids e.g., isoflavones.

Global trade of soybean is estimated to be $26 billion. Africa's share 0.8 %. Sub Sahara Africa's share is 0.48%. Ethiopia's share 0.00323%. Important in sustainable soil fertility management (BNF and crop rotation) Per hectare, a soybean crop yielding 2.5 t seed removes about 125 kg nitrogen, 23 kg phosphorus, 101 kg potassium, 22 kg sulphur, 35 kg calcium, 19 kg magnesium, 192 g zinc, 866 g iron, 208 g manganese and 74 g copper from the soil (Pasricha and Tandon, 1989; Tandon, 1989). Main crop that helped the US sustain maize and cotton production as a rotation crop valuable sources of Ca, P and thiamin. This paper examines breeding and genetic and overall research achievements with an example taken from the Ethiopian context. Ethiopia's production in soybean has increased by over 100 fold in the last decade, with a compound growth of 46% in the last three years (ATA, 2016). And also it is, after conducted deep-dive analyses, one among the ten promising investment opportunities(ATA,2016).

2. SOIL AND CLIMATIC REQUIREMENT

Ethiopia is endowed with favorable climatic and soil conditions for production in South and Western Ethiopia. Soybean grows in altitudes ranging from 1250-2200m.a.s.l. Performs well between 1300-1700m.a.s.l. can also be grown in an area receiving 450 to 1500mm annual rain fall. Minimum of 500mm of annual rain fall for good growth and yield.Moisture requirement per day per plant is about 7.6mm. Critical moisture requirement stages are at germination and grain filling.Temperature ranging from 23-25^{o}C is reported to be optimum.Soybean prefers a slightly acid soil (pH 6.0–6.5) (McLean and Brown, 1984).So, sometimes liming acid soil is important for improving nodulation as there is no nodulation below pH 5(SubbaRao*et al*.,2010).

Soybean: Fastest Growing Crop in the World

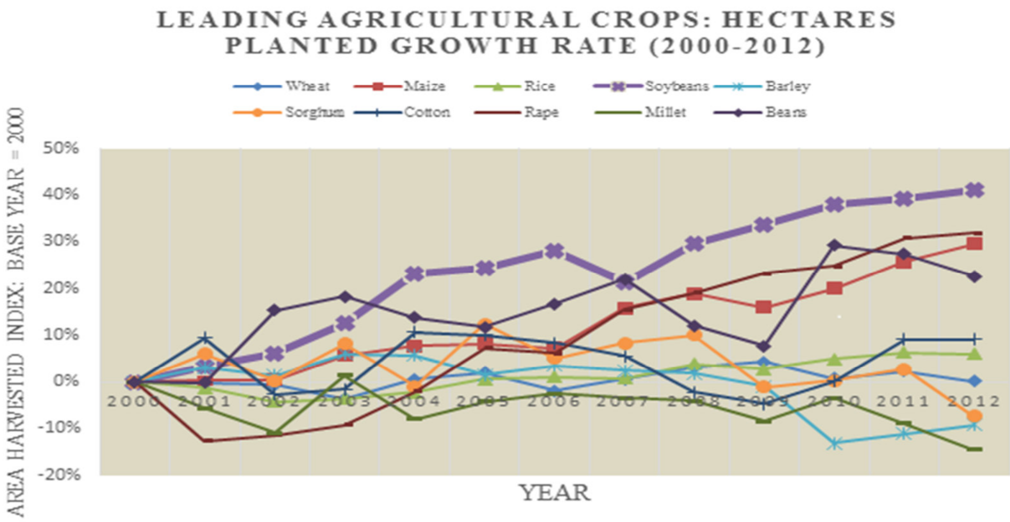

Table 1. Comparison of soybeanarea harvested,total production, productivity, total population and per capita consumption

Country	Area harvested (ha)	Total Production (tons)	% Age share of Global Production	Productivity t ha^{-1}	Population	Per capita consumption
World	111544703	276032362		2.474634	7162118	38.5
Africa	1790547	2245366	0.8	1.254011	1110636	2.02
USA	30703000	89483000	32.42	2.914471	320051	279.59
+Brazil	27906675	81724477	29.6	2.928492	200362	407.88
South Africa	517000	785000	0.28	1.518375	52776	14.87
Ethiopia	27448	49110	0.018	1.789201	94101	0.52

Sources: CSA

Table 2. Total area coverage, production, and productivity of soybean in the main cropping season on the farmer holdings in Ethiopia for the period 1999-2010

Production Year	No. of holders	Area of coverage (ha)	Total production in Tone	Productivity t/ha
1999-2001		NA	NA	NA
2002		1769.47	1620.54	0.92
2003		1027	454.70	0.45
2005		2606	833.50	0.32
2006	29,923	3327	3,8119.00	1.15
2007		7807	8,400.64	1.07
2008		6236	7,898.90	1.27
2010		11261.12	15,824.41	1.41

Source: Central Statistical Authority (CSA), statistical bulletins for the periods 2000-2011; NA=Not available

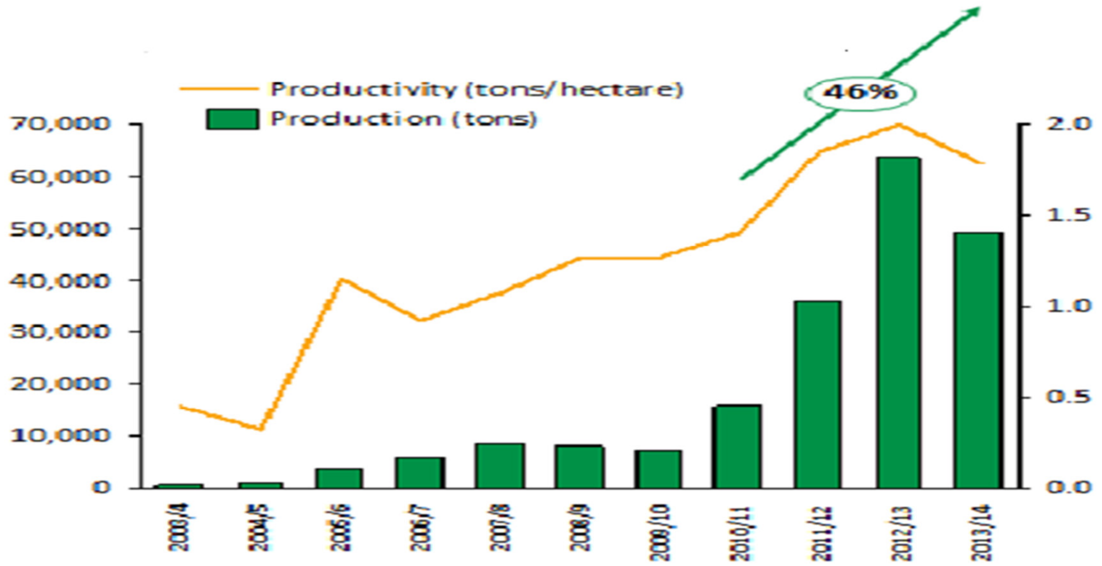

Figure 1 Soybean production and Productivity in Ethiopia (ATA, 2015)

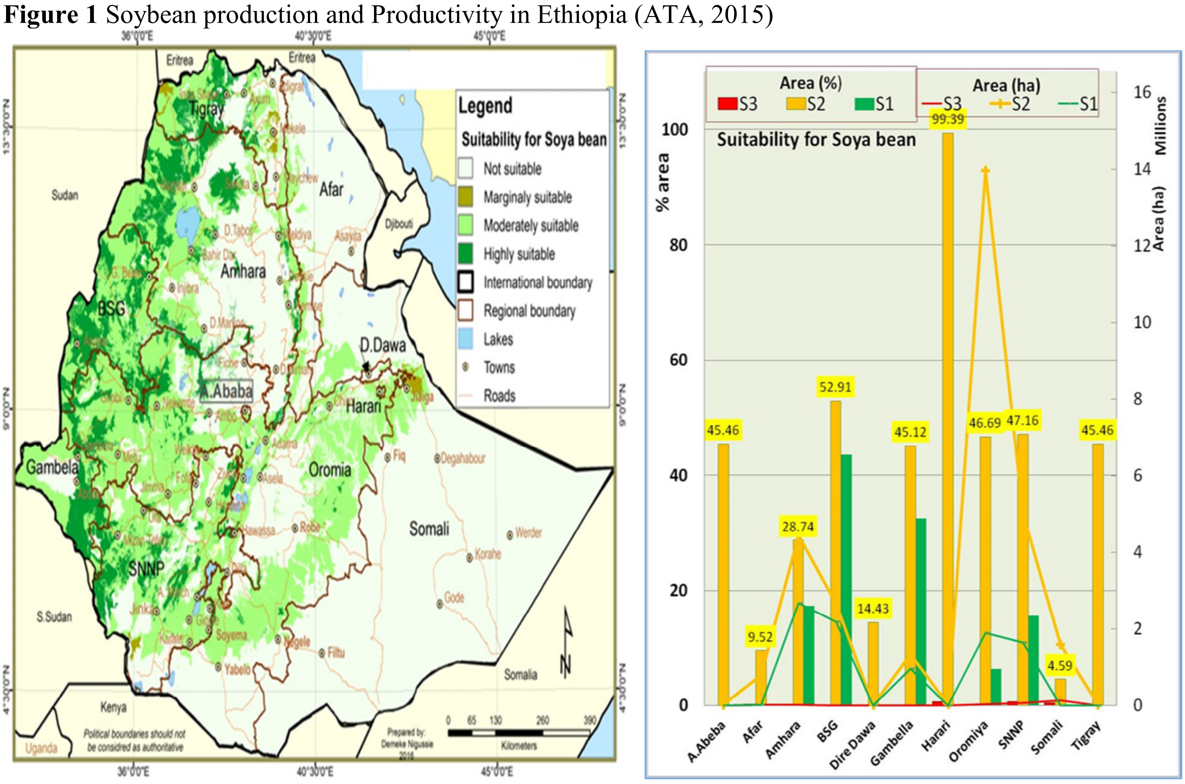

Figure 4:Soybean suitability map in Ethiopia (Adopted from Demeke Mekonnen, 2016)

3. WHY LOW PRODUCTIONS OF SOYBEAN IN ETHIOPIA

There are a huge gap soybean yield on research station (2.5 t ha^{-1}) and that of on farm fields (1.2-1.9 t ha^{-1}).The theoretical limit of soybean productivity was suggested to be 8 t ha^{1} basedon the energy available in the field (Specht, *et al*., 1999). However, world productivity during 2016 was 3.72 t ha^{-1}.The major reasons for low productivity of are: (i).limited varietal stability and narrow genetic bases of soybean cultivar;(ii) lack of access to irrigation facilities; (iii) insect pest and diseases; (iv) emerging multi nutrient deficiencies with the application of only phosphorus and nitrogen to major crops by farmers, and that often below therecommended; (v) low use of rhizobial inoculant ;(vi) high density planting and low fertilization ;(viii) limited access to improved soybean seeds and (ix) poor agronomic practices i.e. low fertilization, weeds and low plant populations, low density planting

4.MAJOR SOYBEAN BREEDING OBJECTIVES

To collect, evaluate, document and utilize and maintain soybean germplasm. The breeding objectives determine the direction of any breeding programmes. In Most of the case high yield dwarf stature, earliness, resistance to biotic and abiotic and drought and lodging stresses. These breeding priority areas, which becomes the breeding objective, are described below.

4.1. Soybean Breeding and Genetics Efforts

- **High yield:** Soybean grain yield is a major breeding objective. Progress has been made, but not at the rate achieved in cereal crops such as corn. The major yield components are numbers of nodes per plant, number of pods per node, number of seeds per pod, and seed size
- **Tolerance to soil acidity:** A report by Waluyo *et al*. (2004) showed that under acidic soil conditions, calcium and phosphorus were limiting factors for BNF. However, the symptoms probably result from a combination of calcium deficiency and aluminium and manganese toxicity (Borkert and Sfredo, 1994).
- **Efficient BNF**: Soybean is the single most important source of BNF among all of the crop legumes (77%), consistent with it composing 68% of global crop legume production (Herridge*et al*. 2008). The breeding approach for enhanced atmosphericnitrogen fixation is has not been success soybean (Herridge*et al*., 2001). Soybean fixation characteristics to end to be polygenic in inheritance (Nicolas *et al.,* 2002) and seem to carry over into improved production via increased overall soybean performance (Herridge and Rose, 2000). Graham and Vance (2000) reviewed possible molecular technologies that could increase soybean fixation. However, at this stage none has been successfully used.
- **Meet processor's requirement:** Limited domestic crushing capacity in Ethiopia.This deprives farmers of adequate net returns and creates disincentives for them to continue to process soybean. This implies an incomplete value-chain development. At the same time to avoids subsidiary to petrol, if we engage the subsidiary to the poor farmers and to boost the agro-industries, to produce soybean oil, which is also used for production of biodiesel.
- **Big seed size:** Seed size can be lowered as the amount of nutrients and water absorptions affects and infection by diseases. Yield is decease as the seed size lowers. So, to get big seed size vegetable soybean with a large seed size (>30 g 100^{-1} dry seeds) is the best option than that of grain soybean. Vegetable soybean slightly sweeter as compared the grain type,which is oily and slightly bitter.
- **High oil quality:** Soybean is the world's leading source of vegetable oil, accounting for more than 75% of the market share. Breeding objectives include an increase in oil content as well as improvement in oleic acid and reduced linolenic acid for high oil quality
- **Seed protein:** Soybean is also the leading source of protein meal. Because seed oil and seed Protein are negatively correlated, breeding has tended to focus on developing cultivars with a high protein and low oil content.
- **Early maturity for short growing season environments:** Maturity has an influence on where the new variety will be grown and best adapted in what production system or cropping sequence, and has an effect on yield and seed quality
- **Change in maturity Duration / Earliness:** Earliness the most desirable character with the advantage that requires less crop management period, less insecticide sprays, permits new crop rotations

5. GERMPLASM ENHANCEMENT

5.1 Process of Hybridization:

According to RishnaHamal (2010), the following steps need to follow for proper hybridization. These are:

(a) Selection of parents: According to Brown *et al* , (2011 In deciding which parents are to be used in breeding scheme there are two evaluation possible Phenotypic and genotypic evaluation. Male and female parents, with desirable characters are selected from the viable materials. Both the parents should mature at the same time.

(b) Emasculation: Removal of anthers from bisexual flowers before they dehisces or shed their pollen is known

as emasculation. It is done in order to prevent self-fertilization. Emasculation is not necessary in the parents are monoecious.
(c) **Bagging**: After emasculation, flower buds are kept enclose in bags made up of cloths, plastic or polythene etc. It is done to prevent pollination through unknown pollen.
(d) **Crossing**:It is an artificial pollination. Pollens are collected from the desirable male flowers. These collected pollens are then dusted on the stigmas of pistils. After crossing the female flowers are bagged again.
(e) **Labeling**: The female parents are then labelled properly. The labelling should bear the following information.
(i) **Serial number**:
(ii) **Details of male parents and female parents**:
(iii) . **Date of emasculation and crossing**:

Soybean is not native to Ethiopia. Its introduction is very recent. Consequently, the genetic diversity is very limited. Introduced more than 500 soybean germplasm (both commercial and accessions) from the United States Genetic Resource Center and other sources. Pawe Agricultural Research Center also introduces 15-30 genotypes every year from International Institutes of Tropical Agriculture (IITA).

Table 5. Germplasm and breeding populations introduced from the USA

No.	Type of germplasm	Year			Total
		2014	2015	2016	
1.	Lines /varieties	62		196	258
2.	Segregating generations(F_2)		77		77
3.	Segregating generations(F_3)			11	11
4.	Brazilian origin lines		16		16
5.	Rust resistant lines			118	118
6.	Low P lines			40	40
	Total	62	93	365	520

6.DEVELOPMENT OF RECOMBINANT INBRED LINES IN ETHIOPIA

Selection in a population through hybridization is more common in the development of soybean varieties (Fehr, 1987). Soybean hybridization was started in Ethiopia in 2010 at Jimma Agricultural Research Centre using seven parental lines were bred using sexual hybridization (Abush, Personal communication). With the main method of soybean varieties crossing and the main selection approach is of modified single seed decent, and hence rather than taking single seed from an individual plant, breeders harvest a single pod from a single plant and use for the next season. According to Panthee 2004 after threshing, seeds are mixed well and divided into two equal parts, with one part planted the next season and the other kept in reserve.

Crossing effort is under way at Pawe Agricultural Research Center.one hundred eighty inbred lines were selected in the year 2014 from 9x9 parental crosses made in 2010, and hence some of the inbred lines from the local crosses are currently in advanced variety trials, *viz.*, pre-national and national variety trials. Eighty F4 generations soybean crosses made at Jimma are under evaluation in the year 2016 at the same time over 100 successful F1s are crosses are made in the year 2016.

Single seed descent method of selection

Rather than taking single seed from an individual plant and use it for planting the next season. Seeds harvested from F_1 plants are space planted in F_2. A single seed harvested from each F_2 plant is used to plant the F_3. Succeeding generations through the F_5 are likewise planted from single seeds harvested from each plant grown in the preceding generation. In the F_5 generation plants are harvested and a progeny row grown in the F_6. A preliminary yield trial is grown in the F_7 and yield trials continued through the F_{10}.Some breeders combine single seed descent with the pedigree selection procedure, by growing only the F_3 and F_4 by single seed descent to accelerate the time required to reach a yield trial.

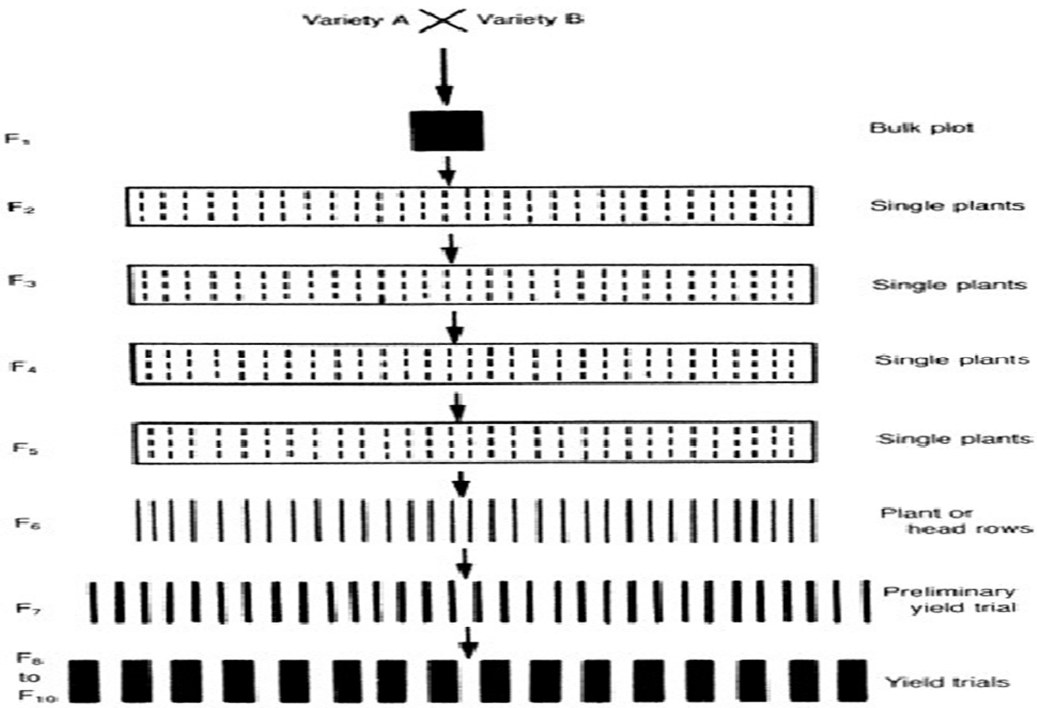

Figure 5.Flow chart of modified single seed decent (Adapted John Milton Poehlman David AllenSleper, 1959)

7. RELEASED SOYBEAN IN ETHIOPIA

So far in Ethiopia, twenty-five soybean genotypes have been released as a direct introduction. When a variety has been registered in another country and has entered general cultivation, it is wasteful to start the entire release procedure from a zero baseline. This includes the old soybean US-bred variety (Clarck-63k). The released soybean variety as direct introduction doesn't increase the production and productivity, as expected due to the susceptibility of diseases and insect pest. The challenge of direct introduction of soybean, both the commercial as well as the exotic, is there is no assigned government body for the introduction and explorations. So, the fragmented research systems are now tried to introduce parental lines for hybridization

Table 4. Name of varieties, maturity type, altitude, year of release and ecology of adaptation soybean varieties in Ethiopia

S.N.	Variety	Maturity Type	Altitude (m.a.s.l.)	Breeder/ Maintainer	Year of Release/ Register	Resistant to	Ecology/Region (where grown
1.	Gizo(TGX-1885-33F)	Medium	520-1800	PARC/EIAR	2010	Bacterial purple, blight and Viral diseases	Long rainfall areas of western and south western part of the country
2.	Gishama(PR-143-(26))	Medium	520-1800	PARC/EIAR	2010	Bacterial purple, blight and viral diseases	>>
3.	BOSHE(IAC-13-1)	Medium	1200-1900	BARC/OARI	2008	Bacterial purple, blight and viral diseases	Intermediate & long rainfall areas
4.	Dhidhessa(PR-143-81-EP-7-2)	Medium	1200-1900	BARC/OARI	2008	Bacterial purple, blight and viral diseases	Intermediate & long rainfall areas
5.	Awassa-95(G 2261)	Early	520-1800	AwARC/SARI	2005	Bacterial purple, blight and viral diseases	
6.	AFGAT(TGX-1892-10F)	Medium	750-1800	AwARC/SARI	2007	Anthracnose	
7.	KORME(AGS-129-2)	Medium	1200-1900	BARC/OARI	2011		
8.	Davis	Medium	1000-1700	AwARC/SARI	1981/2		
9.	Cheri(IPB-81-EP7)	Medium	1300-1850	BARC/OARI	2003	Bacterial purple, blight	Intermediate & long rainfall areas
10.	ETHIO-YUGOSLAVIA	NA	NA	BARC/OARI	2007		
11.	KATTA(PR-145-2)	Medium	1200-1900	BARC/OARI	2011		
12.	AGS-7-1	Early	1200-1700	HWARC/SARI	2012		
13.	NOVA	Early	1200-1700	HWARC/SARI	2012		
14.	Wello(TGX-1895-33F)	Medium	520-1800	SARC/ARARI	2012		
15.	Belessa-95(PR-149)	Late	520-1800	AwARC//SARI	2003	Bacterial purple, blight	Long rainfall areas of western and south western part of the country
16.	Wegayen(TGX-1998-29F)	Late	520-1800	PARC/EIAR	2010	Bacterial purple, blight and viral diseases	
17.	Clark 63k	Medium	100-1700	AwARC/SARI	1981/2		
18.	Coker -240	Medium	700-1700	AwARC/SARI	1981/2	Bacterial purple, blight and viral diseases	
19.	Williams	Early	1000-1700	AwARC/SARI	NA		Short rainfall areas of western and south western part of the country
20.	Jalale(AGS-2017)	Medium	1300-1850	BARC/OARI	2003	Bacterial purple, blight	Intermediate & long rainfall areas
21.	Crowford	Early	700-1700	ARARC//SRARI	NA		
22.	Gazale	NA	800-1700	AwARC and PARC	2015	Moderately resistant to major soybean diseases	
23.	Pawe 01 (PARC-2013-2)	NA	520-1800	PARC/EIAR	2015	Resistance to soy-mosaic virus, moderately resistance to leaf blotch	
23.	Pawe 02 (PARC-2013-3)	NA	460-1600	PARC/EIAR	2015	Resistance to soy-mosaic virus, moderately resistance to leaf blotch	
24.	Nyala	Medium	NA	AwARC and ARC	2014		
25.	Hawasa-04(AGS-7-1)	Medium	NA	AwARC	2012		

Source: MOANR (2016), NA=Not available

8. PERFORMANCE OF RELEASED SOYBEAN VARIETIES ACROSS LOCATIONS

The final stage in the breeding cycle will involve lines that are considered pure lines (non-segregate). At this stage more extensive testing of the few best recombinants from a cross is done for agronomic performance and end use quality or other complex traits. Multi environment testing is done for adaptation and stability, and environments may be locations or a combination of locations and years. Nineteen released varieties of soybean have been evaluated in eight different locations of Ethiopia. Both varieties and GEI showed a highly significant difference in grain yield. This is to help review the recommendations.

Table 5. Performance of the released soybean variet**i**es across diverse agro-ecologies of 19 released soybean varieties evaluated across eight environments.

S.N.	Varieties	Locations (kg/ha)								Mean
		Assosa	Jima	Pawe	Mankush	Tepi	Sirinka	Humera	Abobo	
1	Belesa-95	2195.3^{f-i}	1420.9^{hg}	1996.0^{b-f}	2142.3^{abc}	1786.0^{a-d}	2636.8^{a-d}	405.3^{b}	837.4^{abc}	1677.5
2	TGX-1332644	2119.2^{hi}	826.6^{h}	1330.9^{ef}	2755.3^{a}	1642.1^{a-d}	2311.4^{b-e}	585.0^{ab}	1086.3^{abc}	1582.1
3	Wegayen	2315.8^{e-i}	1448.4^{hg}	2018.3^{b-f}	1977.6^{abc}	690.5^{b-d}	1267.7^{e}	479.0^{ab}	1091.5^{abc}	1411.1
4	AFGAT	3018.0^{a}	2514.5^{ede}	1833.6^{c-f}	2480.2^{ab}	3698.6^{a}	2743.1^{abc}	505.1^{ab}	817.5^{c}	1893.1
5	Gizo	2734.1^{fg}	1834.6^{fg}	2990.8^{ab}	2210.8^{abc}	1480.3^{b-d}		687.3^{ab}	1148.2^{abc}	1869.4
6	Gishama	2325.8^{e-g}	1027.5^{h}	2026.3^{b-f}	2115.8^{abc}	2896.7^{abc}	3696.4^{a}	680.2^{ab}	1289.6^{a}	1765.9
7	Awassa-95	2804.4^{a-c}	2211.8^{d-f}	2055.7^{b-f}	1359.1^{abc}	1902.5^{cd}		539.8^{ab}	944.2^{abc}	1688.2
8	Davis	2557.5^{b-f}	2645.8^{b-d}	2559.2	2176.5^{abc}	2126.5^{b-d}	1877.1^{c-e}	489.1^{ab}	1207.9^{ab}	1955.0
9	Williams	2663.2^{a-e}	2883.1^{a-c}	1547.2^{d-f}	1839.6^{abc}	1278.6^{cd}	1392.6^{e}	841.5^{a}	1167.4^{abc}	1701.6
10	Nova	1935.4^{i}	1014.9^{h}	949.0^{f}	733.4^{c}	657.9^{cd}				1058.1
11	Crawford	2899.3^{ab}	2575.9^{b-e}	2033.1^{b-f}	1362.9^{abc}	2310.6^{a-d}	1254.4^{e}	570.6^{ab}	1054.7^{abc}	1757.7
12	Boshe	2139.4^{ghi}	1939.2^{e-g}	2869.4^{abc}	2536.2^{ab}	2483.8^{a-d}	1659.5^{de}	739.8^{ab}	1090.8^{abc}	1932.3
13	Jalale	2289.2^{e-i}	2337.8^{e-f}	2117.8^{b-e}	1798.8^{abc}	945.4^{d}	1425.7^{e}	542.9^{ab}	1094.5^{abc}	1569.0
14	Cocker-240	2406.0^{d-g}	3196.7^{ab}	3125.5^{ab}	1287.8^{abc}	3460.5^{ab}	2053.5^{c-e}	509.7^{ab}	1037.0^{abc}	1990.4
15	AGS-7-1	2962.6^{a}	1981.1^{e-f}	3041.6^{ab}	1827.7^{abc}	1344.3^{b-d}	2111.5^{b-e}	357.6^{b}	989.9^{abc}	1827.0
16	Clark 63k	2200.5^{f-i}	2507.5^{c-e}	3690.1^{a}	1461.8^{abc}	2722.4^{a-d}	2513.3^{b-e}	711.7^{ab}	1013.4^{abc}	2102.6
17	Wello	1521.7^{j}	902.3^{h}	1672.2^{d-f}	1845.3^{abc}					1485.4
18	Nyala	2515.2^{c-g}	3329.0^{a}	2804.2^{abc}	1153.5^{bc}	1178.7^{cd}	1358.5^{e}	352.8^{b}	1047.3^{abc}	1717.4
19	Gozela	2413.5^{d-g}	1012.2^{h}	2329.0^{b-e}	2012.6^{abc}	658.7^{cd}	3154.1^{ab}	846.7^{a}	1017.9^{abc}	1680.6
	Mean	2421.90	1979.47	2262.61	1846.17	1539.66	2097.04	579.05	1055.03	1719.2
	CV (%)	9.5	19.5	30.2	50.14	27.6	29.5	43	21.8	29.1
	LSD (0.05)	383.6	639.6	1131	1533	1468	1072	415.6	383.3	615.2

9.SOME IMPORTANT FEATURES OF RECENTLY RELEASED VARIETIES

Larger seed size: Large seed size is one of the major traits of interest of processing industries. Nyala and Gozella showed 20.2 and 5.6% 100-seed weight advantage over the Standard check(Awassa-95), respectively.

Moderately higher grain yield: Nyala produced 5.73% yield advantage over the standard check. The second candidate Gozella gave almost similar yield with the check.

Shorter plant height: Plant height is not a desirable trait, and hence most of the soybean breeding aims to develop a dwarf and compact plant type. Both candidates showed shorter plant height than the standard check with an advantage of 15.24 and 4.25% for Nyala and Gozella, respectively. This trait is important to minimize the problem of lodging and makes cultural and harvesting operation easier.

Table 6. Oil content of some released varieties

N$^{\underline{0}}$.	Varieties	Mankush (%)	Pawe (%)	Mean (%)
1.	Cocker-240	24.2	22.9	23.6
2.	Bellessa-95	22.8	24	23.4
3.	Wogayen	22.6	21.9	22.2
4.	Boshe	23.03	22.5	22.8
5.	Williams	22.8	21.3	22.1
6.	Clarck 63k	23.8	21.5	22.7
7.	AFGAT	23.77	19.6	21.7
8.	Wollo	22.03	21.6	21.8
9.	Gizo	20.4	19.5	20
10.	Awassa-95	20.37	20.8	20.6
11.	Nyala	21.03	21.4	21.2
12.	Gishama	22.5	21.8	22.1
13.	TGX-1332644	22.2	21.6	21.9
14.	AGS-7-1	23.57	22.8	23.2
15.	Jalale	24.8	21.3	23
16.	Nova	21.87	21.6	21.7
17.	Crawford	22.37	21.3	21.8
18.	Gozella	22.6	21.4	22
19.	Davis	22	21.9	21.9

Sources: PARC, EIAR (2013)

10. FUTURE PERSPECTIVES

In the tropical climate, where there is high temperate and rainfall, the breeding approaches should be focused not only on increasing the seed yield but also in minimizing pod shattering traits, and also in increasing the introduction exotic germplasms for various novel agronomic traits, so that the hybridization and parental selection is becoming easy and effective. The low productivity soybean in Ethiopia, the national average production is around 1.2 -1.9 t ha^{-1}, with a yield gap 2.1- 2.8 t ha^{-1}; with a potential productivity of 4 t ha^{-1} represent a great challenge. Crops have a potential to exhibit better productivity in coming years with the provision of research back up, technology transfer and policy support from the governments. The introduction of exotic soybean germplasms in Ethiopia from different sources by different agricultural research centers need to follow the quarantine rules and regulation, so that to prevent the possible introduction of the undesirable pest in the country. Taking these points in account, research into the following major areas of soybean production is very essential:

- **Earliness for specific agroecology's:** early varieties with, narrow leaf and early type, fit for intercropping with maize (*Zea mays*) and sesame (*Sesamumindicum*) and at the same time to develop high yielder early maturing soybean than previously developed.
- **Yield and oil:** yield is number oneobjective throughout the world irrespective of cropping system or any other factors, this is because farmers are paid on the basis of seed yield and marketing is based on the seed weight.
- **Lodging tolerant/resistance:** resistance to lodging is a quantitative trait with an approximate heritability of 55% (Brim 1973).Lodging is not only impedes harvesting of crops but reduce yield, reduce 100 seed weight, exposure of plants to the sunlight and hence reduces total photosynthesis makes the overall appearance of the crops weaken(Panthee, 2010.), a plant height is not a desirable trait, since a number of studies have shown that a positive correlation between plant height and lodging(Lee *et al*., 1996a, 1996b; Panthee*et al*., 2007).
- **Develop varieties that meet the requirement of the growing industries-**since there is a wide range of genetic variability has been observed in soybeangermplasm (Verma *et al*., 1993), which enables vast potential for exploitation for various useful economic traits, *viz*., biofuel, quality protein(in terms of amino acid profile), high oil content big seed size and minimizing the content of anti nutritive substances such as glycosides, alkaloids and phenol derivate in grain legumes (Kolbe *et al.* 2002).The breeding programmes should focus on the industry utilization of the genetic diversity.
- **Strengthen international linkage (USA, IITA):** for better acquisition of soybean germplasm, which includes primitive cultivars, landraces, wild species closely related to cultivated crop plants, genetic stocks, inbred lines and hybrids.
- **Short stature varieties:** stature soybean can give high yield at high plant populations
- **Strengthen germplasm enhancement program:** through introduction and strengthening local hybridization programmes, the diversity of species is a perquisite for easy and succefull hybridization. Hence, germplasm is essential to meet the breeding objectives.
- **Disease and insect pest resistance:** Pests and diseases pose great challenges to the production of grain legumes (Emden *et al*.1988)**.** Soybean insect pests such as cut worm, green stink bug, aphid, green clover worm, African bollworm, beetle, leaf miner, stem borer (*Dectes texanustexanus*), soybean looper (*Pseudoplusia includens*), web worm (leaf roller) and to just a few of a long list are becoming a major problem. In addition, diseases like bacterial pustules, bacterial blight, soybean rust, soybean mosaic virus, frog-eye leaf are prevalent. According to Panthee 2010, however the development of disease resistance in soybean varieties is amajor objective in soybean breedingfor two reasons: cost of production and environmental protection. The use of a resistant variety helps to reduce production costs by minimizing the use of fungicides. Reduced fungicide use, in turn, helps to protect the environment.
- **Acid tolerant varieties:** to develop acid tolerant genotypes will aid soybean cultivation in acidic soil profiles of the country, *viz.,* high rain fall areas of South West parts of the country.
- **Pod shattering:** high yielding varieties with non-shattering pod characteristics is needed.
- **Vegetable type:** Vegetable soybeans are nutritionally similar or even superior to green peas (Rao*et al*., 1999). There is also a search for tasty soybean rather than that of bean flavor.
- **Soybean processing and utilizations:** besides, the cultural and varietal development suitable food preparation and utilization by local people.
- **Use of molecular techniques:** The integration of conventional and molecular techniques enhances the efficiency of variety development, efficiency of selection and increase the precision of gene introgression (Panthee, 2010). This in turn, to screen thousands of early generation plants and lines.

This has been helpful in advancing useful materials, and hence saved a lot of resources.

- **Irrigation:** Wherever there is feasibility, soybean yields increase as irrigation increases (Gercek *et al*., 2009). Soybean is known to respond significantly to irrigation during flowering and seed formation (Bharambe*et al*., 2002). Similar yields can be obtained by applying a single irrigation at the R4, R5 or R6 stage (Sweeney *et al*., 2003), which are, however, about 20% higher than with no irrigation.
- In contrast to cash markets, which is very centralized, future contracts that legally binding agreements to deliver the commodities at a price, quality, quantity, delivery time and location should be arranged or else soybean should be traded by the floor of regulated futures exchange i.e. Ethiopian commodity exchange (ECX).

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