

Genetic Gains of Soybean [*Glycine max* (L.) Merrill] in Ethiopia: A Review

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Abstract: Soybean [*Glycine max* (L.) Merrill] has a significant role in global agriculture, with its origin in Asia and widespread cultivation in regions like North America, Europe, and South America. In Africa, soybean production started in 1858, with Ethiopia initiating germplasm work in the 1950s and breeding research in the 1970s. The genetic gains achieved through various conventional breeding techniques have resulted in the release of 25 soybean varieties across early, medium, and late maturity classes. This review examines the genetic advancements in soybean breeding in Ethiopia, spanning from the 1970s to the present. In Ethiopia, breeders have employed a range of methods to estimate genetic gain, including direct comparison of cultivars over time and regression of cultivar performance against years of release. These methods have shown substantial yield improvements, particularly in the early and medium maturity classes. For instance, varieties such as Crawford, Wright, and Williams have demonstrated significant yield gains, with a 64.9% increase observed since 1985. The performance of released soybean varieties across different Ethiopian locations highlights significant environmental interactions, with the highest yields recorded in regions such as Assosa, Pawe, and Jimma. Early maturity groups showed maximum mean yields of 2613.06 kg/ha in Assosa, while medium maturity groups peaked in Pawe at 2568.91 kg/ha. Late-maturity varieties performed best in Asossa and Mankush. Despite these gains, challenges remain, particularly with the direct introduction of exotic varieties that often fail to meet production expectations due to susceptibility to diseases and pests. This review underscores the need for continued evaluation and adaptation of breeding strategies to sustain and enhance genetic gains. By understanding past successes and limitations, Ethiopian soybean breeding programs can better allocate resources, adopt new strategies, and ultimately improve crop productivity and resilience.

Keywords: Genetic gain, soybean, yield

INTRODUCTION

Soybeans [*Glycine max* (L.) Merrill] originated in Asia and was later introduced into North America, Europe, and then South and Central America (Jeong *et al.*, 2019). It is one of the most essential beans in the world in terms of production and trade and has become the dominant oilseed (Getnet, 2019). It has a long history in Africa with the first recorded production in the continent in 1858 in Egypt and South Africa (Diers and Scaboo, 2019). In Ethiopia, the introduction of soybean germplasm

work is believed to have been initiated in the 1950s by the Ethiopian Institute of Agricultural Research (EIAR), however, other breeding research has been launched recently in the 1970s. (Abebe and Habtegebriel, 2018) .

According to (Federizzi, 2009), the observed genetic gains in crop improvement disciplines can be used to assess the success of a breeding program over time. In Ethiopia, breeders used various conventional breeding techniques and released 25 soybean varieties in early, medium, and late maturity classes for production. The estimates of genetic progress in breeding soybean show that soybean area and production have become rapidly growing and breeding operations have been carried out in different cultivation environments to achieve success (Fentahun, 2019), as compared to 1970s regional states of Ethiopia like, Oromia, Benishangul Gumz, Southwest Ethiopia region and Amahara regions have shown increased yield potential depending on the three maturity groups (Abebe and Habtegebriel, 2018).

Besides quantifying the progress obtained over a given period, the genetic gain analysis also helps to synthesize other information, such as comparing benefits obtained and challenges by using breeding strategies differently or in different environments (Specht and Williams, 2015). This type of information contributes to an understanding of past events and enables the development of new strategies, adoption of remedial approaches, and more efficient resource allocation, which together increase breeding effectiveness (Abebe and Habtegebriel, 2018); therefore, this review aimed to assess achieved genetic gains and to show gaps in Ethiopia's soybean breeding since the 1970s to now.

Concept of genetic gain

Genetic gain is defined as an improvement in the average genetic value in a population, or an improvement in the average phenotypic value due to selection within a population over a breeding cycle (Jessica E. Rutkoski, 2019). It is also explained as the expected or realized change in the average breeding value of a population over at least one selection cycle for a particular trait (J E Rutkoski, 2019). This change is sometimes called genetic tendency and can be estimated by regressing average breeding values over the years (Cobb *et al.*, 2019).

Genetic gain can be achieved for virtually any trait as long as it is heritable. It can also be achieved for total net merit, which is a combination of multiple economically important traits. Selection for net merit is done using an economic selection index (Hazel, 1943; Smith, 1936) which is a linear combination of different traits of economic importance weighted optimally so that selection based on the index maximizes expected genetic gain in net merit, because the term genetic gain only applies to changes in population mean over cycles of selection, it makes sense to talk about genetic gain in traits that are heritable and conferred by multiple loci. This is because improving such traits can be done most effectively over multiple cycles of selection. Strictly speaking, the genetic gain can only be realized by executing at least 1 cycle of breeding. The breeding cycle required to realize the genetic gain, illustrated in Fig. 1, consists of four parts, generation, evaluation, selection, and recombination.

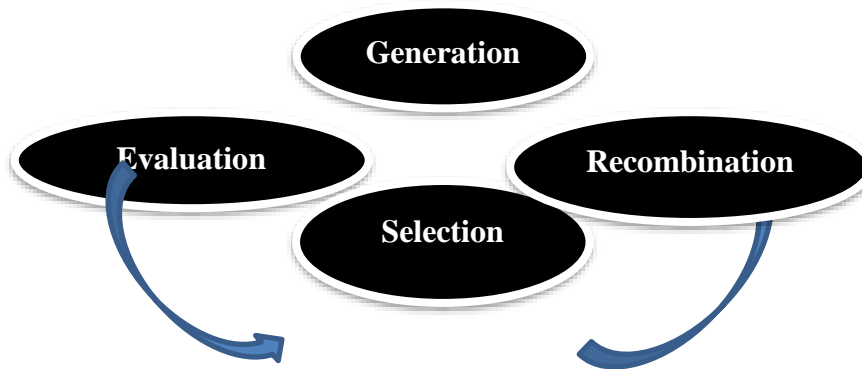


Fig. 1 The breeding cycle required to achieve genetic gain over time

This process is also referred to as “population improvement” or “recurrent selection.” Different breeding materials, such as single non-inbred plants, or families such as inbred lines, may be used for the processes of evaluation, selection, and recombination. For example, an individual’s progeny from open pollination may be used for evaluation, and its progeny from self-pollination for recombination (Ogunniyan and Olakojo, 2014). The breeding materials that are subject to selection are called selection units, those that are evaluated are called evaluation units, and those that are recombined are called recombination units. In self-pollinated crops, the same inbred lines are often utilized as the evaluation, selection, and recombination units (Hancock, 1992).

Importance of knowing the genetic gain

Genetic gain estimates in breeding programs are important to critically analyze efficiency and to plan new actions and strategies also understand changes produced by crop breeding on grain yield and its determinants and also important to evaluate the efficiency of past improvement work on the advances in genetic yield potential and to define future selection criteria to facilitate further progress (Jandong, Uguru and Okechukwu, 2016). Institutions working with annual crop breeding routinely conduct a series of trials to compare elite lines and to release new cultivars; each year lines are replaced in the trials with the expectation that the new ones will be superior. The change in yield means as a consequence of these substitutions may be considered an estimate of genetic gain and it provides information based on data already available from different years and locations.

The application of the concepts and principles of genetic progress from breeding or selection may vary based on the specific objective of the breeder. There are cases when the breeder may seek to know the level of genetic advancement from a single cycle or a series of selection cycles made at a time (Mihret, 2017). In this case, genetic progress under selection is simply measured as the difference between the mean genotypic values of the selected population over the mean genotypic values of the original population and this is important to estimate genetic progress, in this case, emanates from the need to predict the effectiveness of a single or a few cycles of selection (Ustun, Allen and English, 2001). Likewise, the same concept may be applied for another purpose when the breeder intends to know the

level of genetic progress achieved not from a single or a few cycles of selection but from a long-term breeding effort made over time by a breeding program. In this case, the estimation of genetic progress from a breeding program enables us to know the cumulative impacts of long-term breeding efforts. Based on the result of such estimation, the whole breeding program may be revised and redirected and more effective and efficient breeding strategies may be developed (Mihret, 2017).

Methods to estimate the rate of genetic gain

The development of methods to estimate genetic gain to breeding programs and their stakeholders, as genetic gain constitutes a highly relevant indicator of breeding performance and a means to compare different crossing, evaluation, and selection strategies, either through real experiments or simulations (Cobb *et al.*, 2019). The expected gain per unit of time (here denoted as L), usually referred to as the rate of genetic gain ($\Delta g=R/L$), is the most common way to express the gains of programs. Different methods may be used to estimate genetic progress realized from a single or a few cycles of selection and from breeding efforts made over time. Selection efficiency from a single or a few cycles of selection depends on the magnitude of genetic variability among the original germplasm, the heritability of a given trait in a given environment, and the level of selection intensity applied (Congress, Applied and Production, 2002). The higher the level of genetic variability, heritability, and selection intensity for a given trait in a given environment, the higher the expected genetic gain from selection (Malek *et al.*, 2014). The expected genetic gain from selection in this case is a function of genetic variance, heritability, and selection intensity. Components due to genotypic variance and heritability values and, hence, the expected genetic gain from the selection can easily be calculated from the analyses of variance by assuming various observed mean squares equal to their expected mean squares (Nyquist and Baker, 2008).

The accurate estimation of genetic progress realized from long-term breeding efforts made over time is a difficult task but various procedures may be used. Among the available procedures, the performance of cultivars in common environments regressed over years of release as a continuous quantitative variable provided the most direct estimate of genetic progress from breeding and has widely been used in different crops (Gizlice, Carter, and Burton, 1993). Estimating genetic progress is employed as a means to predict the effectiveness of a single or a few cycles of selection. In the other case, genetic progress may be estimated to know the level of genetic progress achieved from the long-term breeding effort made over time by breeding programs. This helps evaluate and revise the whole breeding program to redirect breeding strategies and make them more effective and efficient (Ustun, Allen, and English, 2001). In addition to quantifying the progress obtained in a certain period, the genetic gain analysis also enables aggregation of other information, such as comparison of the gains obtained with the use of different breeding strategies or in different environments (Specht and Williams, 1984). This in turn contributes to the understanding of past events, allows the elaboration of new strategies, adoption of corrective methods, and more efficient resource allocation that together increase the efficiency of breeding programs. Cox *et al.* (1988) viewed the importance of evaluating the genetic improvement of crops from long-term breeding works in two ways: one as a demonstration of the importance of plant breeding to the public and the other as a way of identifying traits or target environments that may require increased efforts by breeders. Despite these benefits, however, it is not an easy task to find accurate estimates of genetic progress realized over time for a given trait. Ustun *et al.* (2001) asserted that the number of genotypes and choice of cultivars for

experimentation may change the estimate. Evans and Fisher (1999) raised another complication that can arise as a result of the possibility of interactions between cultivars and growing conditions. Nevertheless, different methods of estimating the progress in genetic yield potential improvement have been used by different researchers. Evans and Fisher (1999) generally grouped such methods into two: direct comparison of a series of varieties and indirect assessment by sequential comparisons. In the indirect method, comparisons can be compiled serially to provide widely replicated estimates of the relative yield potential of a long series of major cultivars when grown in the environments and with the agronomy to which they were adopted. But Cox et al. (1988) suggested that this method may not be appropriate; it may overestimate the rate of progress, for example, if many of the tested cultivars react differently from the checks to environmental factors. Asrat et al. (2006) and Lange and Federizzi (2009) used this method to estimate the genetic yield improvements in soybeans achieved in Ethiopia and Brazil, respectively. By the direct method of comparing historical series of cultivars side by side (in a common environment), the progress in yield potential of many crops in many environments has been assessed (Evans, 1993). Cox et al. (1988) suggested that this method provides the most direct estimate of breeding progress.

Soybean genetic improvement in Ethiopia

During the last 50 years, a large number of soybean introductions with varying maturity duration were evaluated for adaptation, yield potential, and desirable agronomic characteristics at several locations ranging from 520 to 1900 m.a.s.l in the country. As a result, varieties suitable for production in the country were recommended or released for general cultivation. Since the crop is new to the country, the identification of areas suitable for production was of primary concern in the process of variety development. Soybean is said to be a medium-altitude crop well adapted to areas located in altitudes ranging from 1300 to 1800 m.a.s.l and receiving annual rainfall of 900 to 1300 mm (Ermiyas, 2018). The crop also does well in some areas as low as 500 m.a.s.l and as high as 1900 m.a.s.l that receive a well-distributed average rainfall of 550 to 700 mm throughout the growing period (Hailemariam Habtegebriel, 2022). The varieties recommended or released in Ethiopia are classified into three maturity groups based on the number of days they require to reach physiological maturity (Chemeda Fininsa and Bulti Tesso, 2003). The first maturity groups are early maturing varieties that reach physiological maturity in 90 to 120 days. The early-maturing varieties are suitable for short rainfall areas, and may also suit for double cropping in long rainfall areas. Second medium maturing varieties require 121 to 150 days to reach physiological maturity and are suitable for production in areas with intermediate and long rainfall areas. Third late maturing varieties require more than 150 days to reach physiological maturity and are suitable for production in areas with long growing season length of maturity and their suitability to different agroecologies depends on the length of growing period of the growing agroecology. Comparisons of the yielding potentials of three maturity classes in different years of trials revealed no wide yield gap among them. However, early- and medium-maturity classes, on average, expressed relatively better yielding potential. This could be due to the growing periods at many of the variety testing locations favoring early- and medium-maturity sets, and disfavoring late-maturity sets even though the varieties in this were higher yielding in areas, where the growing season accommodated them. From the mean yield of the 15-year trials, the breeding program learned that focus should be given to the development of early- and medium-maturing varieties in the majority of the test locations (Getnet, 2019). Among the varieties tested in the early-maturity class, Crawford, Wright, and Williams were top-yielding varieties with a mean yield of

1,167.3 kg/ha with the 1985 mean of the top three yielding varieties, there was 64.9% yield gain since 1985. In 2000 and 2019 the mean yield of three top-yielding early varieties were 1,749.9 and 2,098.9 kg/ha, respectively. In the medium- and late-maturity classes, yield gain was observed in the first 5 years trials but no yield gain was observed in recent years. This could reveal that either low-yielding potential genotypes were evaluated or the erratic rainfall was experienced in the country which hindered the genotypes from expressing their full yield potential. However, in the variety testing procedure, entries are promoted from one stage to the next stage of yield testing whenever they are superior to the standard check(s) in yield or other desirable traits (Getnet, 2019).

Released soybean varieties 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. The released soybean variety as a direct introduction doesn't increase production and productivity, as expected due to the susceptibility to diseases and insect pests. The challenge of the direct introduction of soybeans, 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 trying to introduce parental lines for hybridization (Tesfaye, 2018)

Table 1 Name of varieties, maturity type, altitude maintainer, and year of release of soybean

S.N.	Variety	Maturity Type	Altitude (m.a.s.l.)	Breeder/ Maintainer	Year of Release
1	Gizo(TGX-1885- 33F)	Medium	520-1800	PARC/EIAR	2010
2	Gishama(PR-143- (26))	Medium	520-1800	PARC/EIAR	2010
3	BOSHE(IAC-13-1)	Medium	1200- 1900	BARC/OARI	2008
4	Dhidhessa(PR-143- 81-EP-7-2)	Medium	1200- 1900	BARC/OARI	2008
5	Awassa-95(G 2261)	Early	520-1800	AwARC/SARI	2005
6	AFGAT(TGX1892-10F)	Medium	750-1800	AwARC/SARI	2007
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
10	ETHIO YUGOSLAVIA	Late	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
16	Wegayen(TGX1998-29F)	Late	520-1800	PARC/EIAR	2010
17	Clark 63k	Medium	100-1700	AwARC//SARI	1981/2

18	Coker -240	Medium	700-1700	AwARC//SARI	1981/2
19	Williams	Early	1000- 1700	AwARC//SARI	1974
20	Jalale(AGS-2017)	Medium	1300- 1850	BARC/OARI	2003
21	Crowford	Early	700-1700	ARARC//SRARI	1974
22	Gazelle	Early	800-1700	AwARC and PARC	2015
23	Pawe 01 (PARC2013-2)	Early	520-1800	PARC/EIAR	2015
24	Pawe 02 (PARC2013-3)	Early	460-1600	PARC/EIAR	2015
25	Nyala	Medium	NA	AwARC and ARC	2014
26	Hawasa-04(AGS-7- 1)	Medium	NA	AwARC	2012

Source: MOANR (2016), NA=Not available

Performance of released soybean varieties across locations

(Tesfaye, 2018) assessed nineteen released soybean varieties in eight different Ethiopian locations. Grain yield differed significantly between all varieties and genotypes by environmental interactions. The combined mean of released varieties (table 2) shows that there is a yield difference in all locations, with the highest mean yield recorded in Assosa, Pawe, Jimma, and Tepi, respectively, and the lowest mean yield recorded in Humera and Ambo. This indicates the presence of genetic variation among soybean varieties and the ability to select high-yielding and stable variety (s); the environments were variable, as were the responses of soybean varieties across environments.

Table 2 Mean yield of soybean in different environments

Varieties	Locations								Mean
	Jimma	Tepi	Assosa	Pawe	Humera	Ambo	Mankush	Sirinka	
Williams	2883.1	1278.6	2663.2	1547.2	841.5	1167.4	1839.6	1392.6	1701.65
Nova	1014.9	657.9	1935.4	949	0	0	733.4	0	661.32
Crawford	2575.9	2310.6	2899.3	2033.1	570.6	1054.7	1362.9	1254.4	1757.68
Awassa-95	2211.8	1902.5	2804.4	2055.7	539.8	944.2	1359.1	0	1477.18
AGS-7-1	1981.1	1344.3	2962.6	3041.6	357.6	989.9	1827.8	2111.5	1827.05
Gozela	1012.2	658.7	2413.5	2329	846.7	1017.9	2012.6	3154.1	1680.58
Davis	2645.8	2126.5	2557.5	2559.2	489.1	1207.9	2176.5	1877.1	1954.95
Boshe	1939.2	2483.8	2139.4	2869.4	739.8	1090.8	2536.2	1659.5	1932.26

Jalal	2337.8	945.4	2289.2	2117.8	542.9	1094. 5	1798.8	1425.7	1569.0 1
Cocker-240	3196.7	3460.5	2406	3125.5	509.7	1037	1287.8	2053.5	2134.5 8
Clark 63k	2507.5	2722.4	2200.5	3690.1	711.7	1013. 4	1461.8	2513.3	2102.5 8
Hello	902.3	1818.5	1521.7	1672.2	0	0	1845.3	0	970
Nyala	3329	1178.7	2515.2	2804.2	352.8	1047. 3	1153.5	1358.5	1717.4
AFGAT	2514.5	3698.6	3018	1833.6	505.1	817.5	2480.2	2743.1	2201.3 2
Gizo	1834.6	1480.3	2734.1	2990.8	687.3	1148. 2	2210.8	0	1635.7 6
Gishama	1027.5	2896.7	2325.8	2026.3	680.2	1289. 6	2115.8	3696.4	2007.2 8
Belesa-95	1420.9	1786	2195.3	1996	405.3	837.4	2142.3	2636.8	1677.5
TGX- 1332644	826.6	1642.1	2119.2	1330.9	585	1086. 3	2755.3	2311.4	1582.1
Wegayen	1448.4	690.5	2315.8	2018.3	479	1091. 5	1977.6	1267.7	1411.1
Mean	1979.4 6	1846.4 5	2421.9	2262.6 3	518.11	943.9 7	1846.17	1655.5 6	1684.2 8

Source (Tesfaye, 2018)

The estimated genetic gains varied by maturity group and region. The early maturity groups produced a maximum mean yield of 2613.06 kg ha⁻¹ in the Assosa location, while the Humera location produced a minimum mean yield of 526.03 kg ha⁻¹. Pawe had the highest mean yield gain in the medium maturity group, followed by Asossa, Tepi, and Jimma, with 2568.91, 2370.74, 2281.14, and 2223.49 kg ha⁻¹, respectively, and Humera had the lowest mean yield gain in the medium maturity group, with 521 kg ha⁻¹. Asossa had the highest mean yield for the late maturity group at 2210.1 kg ha⁻¹, followed by Mankush at 2191.73 kg ha⁻¹ and Sirinka at 2071.96 kg ha⁻¹, while Humera had the lowest mean yield at 489.76 kg ha⁻¹. As a result, the rank of the groups in terms of mean yield performance changed during the 1970s. The medium maturity group was kept stable, which demonstrated gains in the period mean yield Tesfaye, (2018).

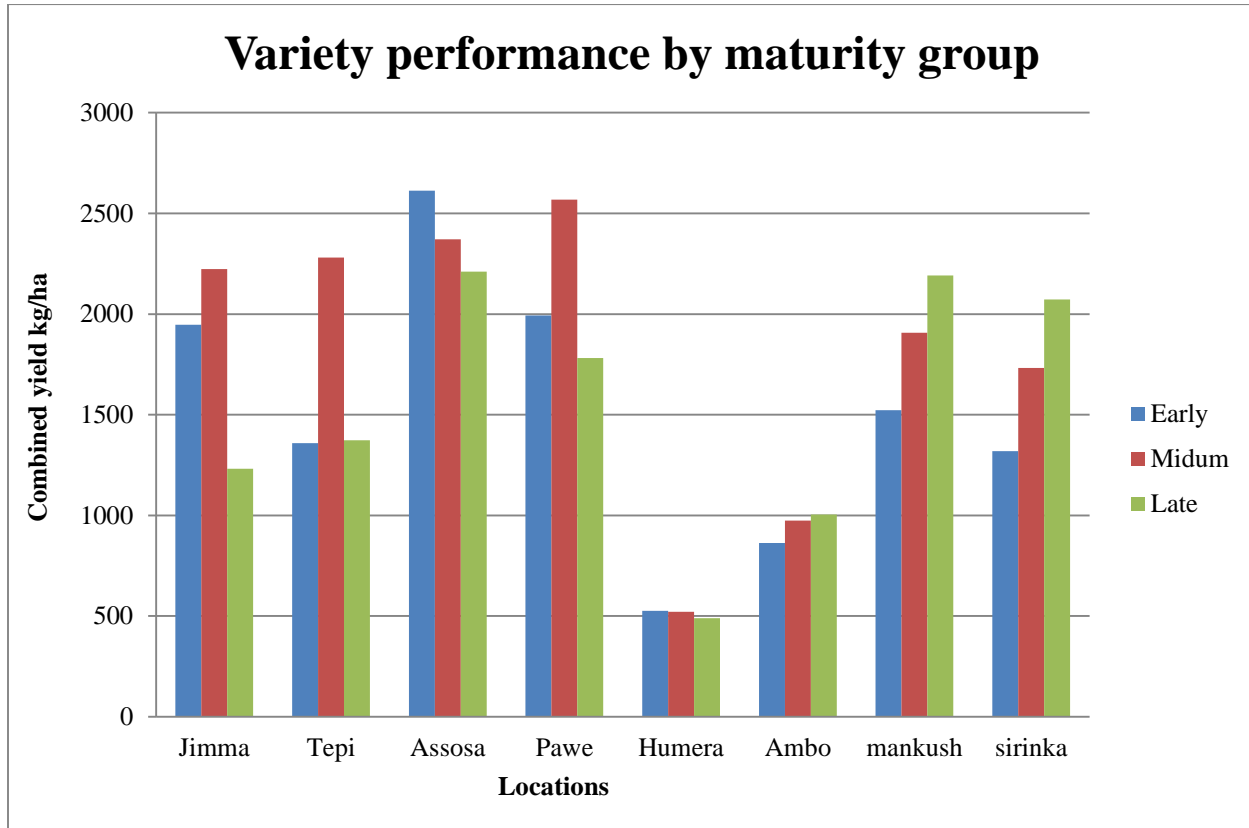


Figure – 1 Variety performance by maturity group (Sileshi, Yirga and Habtegebriel, 2020), evaluated 19 released soybean varieties in Jimma for two years, and the combined mean squares due to varieties revealed highly significant ($P \leq 0.01$) Similarly, the interactions (year x varieties) showed significant differences for all the traits except hundred seed weight. For the last two decades or so, the dominant soybean varieties grown in Jimma and South Western Ethiopia have been Clark 63K and Afgat. Nyala (4.19t/ha), Coker 240 (3.91t/ha), and Williams (3.69t/ha) were identified as the three high-yielding varieties based on their findings over two years with released varieties. These varieties are recommended as substitutes for click and Afgat in Jimma and other southwestern Ethiopian areas. Nyala and Cocker-240 are recommended varieties because they have attractive seed luster, are resistant to lodging, and have a high yield.

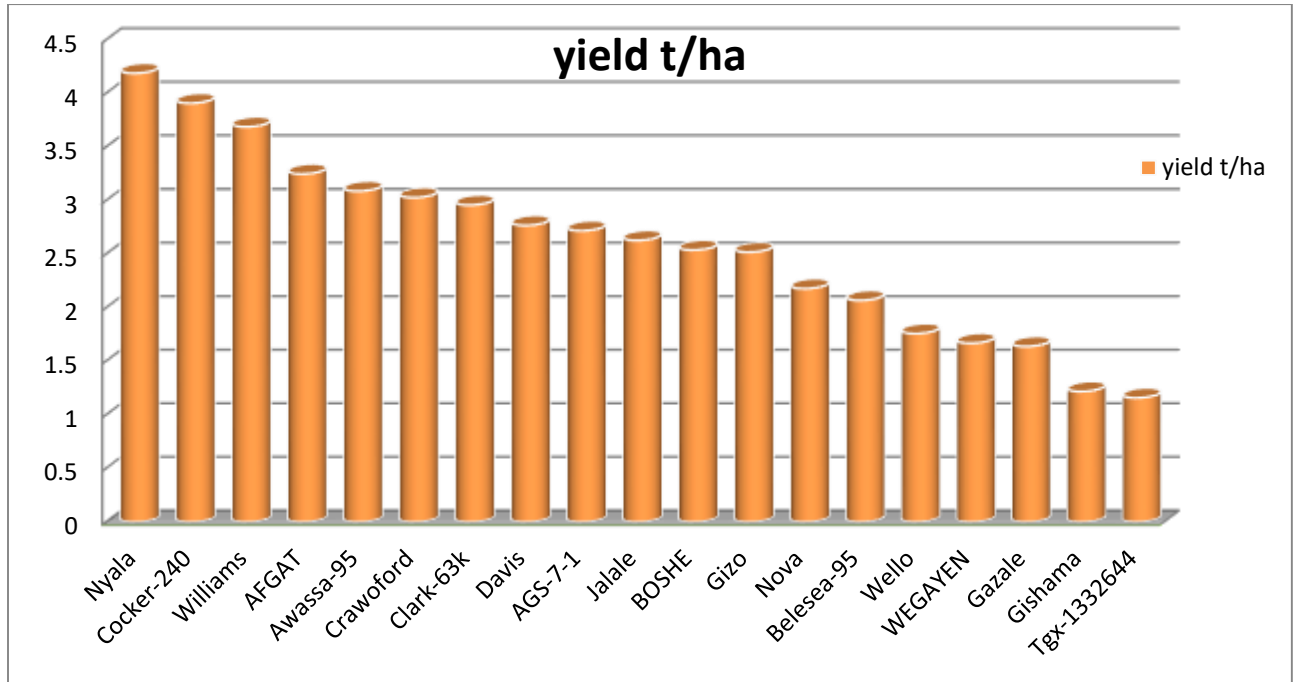


Figure 2 Performance of released varieties in the Jimma location (Sileshi, Yirga, and Habtegebriel, 2020)

Major constraints of soybean production

Soybean breeding and production have been going on in Ethiopia since the 1950s, it was not easy to achieve wider dissemination and production of the crop. The contribution of research outputs in terms of improved varieties and associated agronomic practices takes the lion's share of improvement. However, the yield trend for major cereals has shown a significant increase in the last ten years, which is highly associated with the use of seeds of improved crop varieties, fertilizer application, and better extension services, while limited knowledge in the use of soybean in cropping systems as compared to other crops (Fentahun, 2019). Based on the energy available in the field, the theoretical limit of soybean productivity was proposed to be eight t/ha¹ (Specht, et al.,1999). However, Ethiopia's maximum productivity to date has been 4.19t ha⁻¹, with the main reasons being,

1. Limited varietal stability and narrow genetic bases of soybean cultivar
2. Insect pests and diseases
3. Lack of access to irrigation facilities
4. High-density planting and low fertilization
5. Limited access to improved soybean seeds and
6. Poor agronomic practices

Though increased production and productivity are not the only problems associated with breeding, the contribution of extension services to familiarize the crop throughout the country is also crucial.

Future perspectives

Breeding strategies should prioritize not only increasing seed yield but also increasing the introduction of exotic germplasms for various novel agronomic traits, so that hybridization and parental selection become simple and effective. Ethiopia has a low-productivity soybean, with a national average production of around 1.2-4.19 t ha⁻¹, and potential productivity of 8 t ha⁻¹. The crops have the potential to be more productive in the coming years if governments provide research support, technology transfer, and policy support. The introduction of exotic soybean germplasms into Ethiopia from various sources by various agricultural research centers must adhere to quarantine rules and regulations to avoid the possible introduction of an undesirable pest into the country. Given these considerations, research into the following major areas of soybean production is critical:

- Strengthen germplasm enhancement programs: Through introducing and strengthening local hybridization programs, species diversity is required for easy and successful hybridization. As a result, germplasm is required to meet the breeding objectives. A wide range of genetic variability has been observed in soybean germplasm allowing for a significant potential for the exploitation of various beneficial economic traits such as biofuel, quality protein (in terms of the amino acid profile), high oil content, large seed size, and minimizing the content of ant nutritive substances such as glycosides, alkaloids, and phenol derivate in grain legumes. (Chen and Nelson, 2005).
- Disease and insect pest resistance: Pests and diseases pose significant challenges to grain legume production. (Emden et al.1988). Soybean insect pests such as cutworm, green stink bug, aphid, green clover worm, African bollworm, beetle, leaf miner, stem borer, soybean, webworm (leaf roller), and to name a few. Furthermore, diseases such as bacterial pustules, bacterial blight, soybean rust, soybean mosaic virus, and frog-eye leaf are common. However, according to (Calvo *et al.*, 2008), developing disease resistance in soybean varieties is a major goal in soybean breeding for two reasons: cost of production and environmental protection. The use of a resistant variety reduces production costs by reducing the need for fungicides. Reduced fungicide use, in turn, aids in environmental protection.
- In contrast to cash markets, which are highly centralized, future contracts that are legally binding agreements to deliver commodities at a price, quality, quantity, delivery time, and location should be arranged, or else soybeans should be traded on the floor of an Ethiopian commodity exchange. (ECX).

CONCLUSION

Soybean has the potential to play a significant role in Ethiopian agriculture. It has a high yield potential, a wide range of adaptability, a high nutritional value for food and feed, and a significant role in cropping systems. In Ethiopia, soybeans are divided into three types: early, medium, and late. The genetic gain results of the three maturity classes in variety trials revealed that early- and medium-maturing varieties have potential for Ethiopia. They have potential in short and intermediate-rainfall areas and are suitable for multiple-cropping systems in extended-rainfall areas.

Because to soybean is an exotic crop that was only recently introduced into the country, there is insufficient diversity to effectively run a long-term genetic improvement program. In the past few years, there has been a limited introduction, which is the only source of new genes for soybean improvement. Furthermore, the Ethiopian breeding program has primarily focused on evaluating introductions to identify suitable varieties that are well-adapted to the country. As a result, a hybridization program needs to be launched to generate new genetic variability, and the released varieties must be popularized among smallholder farmers, with special attention paid to incorporating the crop into existing cropping systems and diets.

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