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Evaluation of Biomass Yield and Nutritional Composition of Soybean *(Glycine Max* (L.)Merrill*)* Varieties Grown in Low Land Areas of Eastern Amhara, Ethiopia

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Abstract

The experiment was conducted in three locations Jari, Chefa and Sirinka of Eastern Amhara to select the best performing varieties, in terms of biomass yield, chemical composition, haulm yield, seed yield and other agronomic characteristics of *Glycine max* (L.) Merrill grown under the rain- fed condition of lowland areas of Eastern Amhara in a randomized complete block design with tree replications. Twelve released soybean varieties were Afgat ,Belesa-95, Boshe , Cheri , Dhidhessa, Gishama , Gizo, Korme, Pawe-03, katta, Wegayen and Wollo were used as a treatments. The seeds were planted in 40 cm between rows and 10 cm between plants on a plot size of 3.2m*4m. Spacing between blocks and plots were 1 and 0.5m, respectively. The seed rate was 60 kg/ha and a fertilizer rate 100 kg/ha NPS was applied during seed planting. The combined analysis of variance over two years at location Jari for dry matter yield of varieties Afgat, Gizo, Pawe-03, Wogayen and Wollo were significantly higher as compared to other soybean varieties. The combined analysis across locations at Jari and Sirinka (2019-second year) showed that varieties Afgat, Gishama, Gizo, Pawe-03, Wogayen and Wollo had higher dry matter yield and varieties Gishama (3.97 t/ha), Gizo (3.60 t/ha), Pawe-03 (4.04 t/ha) and Wogayen (3.36 t/ha) had higher haulm yield as compared with other varieties. The combined analysis across locations at Jari and Sirinka (2019) showed that varieties Pawe-03(2951 kg/ha), Gizo (2862 kg/ha), Afgat (2859 kg/ha), Gishama (2654 kg/ha),Wollo (2461 kg/ha) and Wogayen (2404 kg/ha) had higher seed yield as compared with other varieties. The variety Wollo gave higher crud protein content in two locations (Jari and Sirinka) .Therefore, varieties Afgat, Pawe-03 and Wollo were recommends for the given areas of Jari , Chefa, Sirinka and could be produced in similar environments for the best of produced optimal amount of dry matter, haulm and seed yield and good protein supplement for production of ruminants.Thus, further researches will be needed to investigate on the utilization of livestock.

Key words: *Crude protein content, Dry matter yield, Soybean*

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Introduction

The low productivity of Ethiopian livestock is a result of several limiting factors among which feed is the major one.The country as a whole the existing feed does not meet the amount required by livestock. Natural pastures are the most important livestock feed resource. In most parts of the country natural grasslands are confined to degraded shallow upland/highland, fallow crop lands and soils that cannot be successfully cropped due to physical constraints such as flooding and water logging. They are low yielding and their production is insufficient and grazing conditions are only favorable for four to five months per year. For several decades, grazing areas have been shrinking and likely to continue to do so because of rapid expansion of cultivated land for crop production to provide food for the ever-increasing human population. As a result, there is always likely to be limited feed resources for the existing livestock population. Therefore, selection of high-yielding and better-quality forage varieties, and development of improved forage production systems are critically important (Alemayehu Mengistu and Getnet Assefa, 2012; Alemayehu Mengistu *et al*., 2016).

In the past four decades, extensive research and development has been carried out in Ethiopia to test and evaluate the adaptability and performance of different forage species under different agro-ecological zones. An array of potential grass, legume and browse tree forage species have been selected for development programs. The selected species showed better yield and quality than those in the naturally occurring swards. The introduction and development of selected forage species into the farming system was expected to help solve the severe forage deficit that the country is presently facing (Alemayehu Mengistu *et al*., 2016) .In the dry season, when available feed in the form of grazing ,hay and crop residues is not enough to support animal productivity , supplementation with forage legumes increases animal productivity (Murphy and Colucci, 1999). One among potential forage legume resources is the introduction and adoption of the soybean forage.

Soybean (*Glycine max* (L.) Merrill*)* is a major legume crop grown for its protein and oil rich seeds but it also makes valuable forage for grazing, silage and hay. It is a fast growing herbaceous annual native to Asia that is currently grown worldwide. It is an erect leguminous plant, which grows up to a height of 1.3 m. Like other forage legumes, soybean forage has many

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valuable traits as fodder. Soybean leaves and steams can be grazed. Ensiled or dried to make hay. The foliage is very palatable to cattle and has a high nutritive value and good digestibility (Koivisto, 2006).

Ideally soybean forage is suited for Winnter cropping in Ethiopia; it is tolerant of drought and thrives when other forage legumes like alfalfa are not available. Forage soybean can be sown alone or in combination with other forage species such as sorghum (Fujita *et al*., 1990). It should be sown on a well prepared seed bed once average temperatures are higher than 10^{o}c. It grows quickly and can provide 5 to 10 t DM/ha within 3-4 months (Doo-Hong Min, 2012; Koivisto *et al*., 2003). It can be first grazed when it reaches 60 cm in height (Lugin buhl, 2006). The large increase in forage yield and small effect on forage quality associated with growing cultivars of later than normal maturity suggests that cultivars of later maturity, when compared to locally adapted cultivars for seed production, are often the best choice for soybean forage production (Hintz *et al*., 1992).

The nutritive value of soybean plant can be comparable to early bloom alfalfa (that shows high protein content and very digestible to mature ruminant animals). Lactating dairy cows and growing heifers can have similar performance when given either soybean hay or alfalfa forage.Palatability is not usually concern when feeding soybean forage (unless the forage is moldy or dusty). In three to four months after seeding it produces cut hay equal in quality to alfalfa cut hay (Hintz *et al*., 1992).

Soybean forage is relatively rich in protein, which varies between 11% and up to more than 22% of the DM. Fibre content is also quite variable, with ADF content ranging from 20% to more than 45% of the DM. It is relatively poor in lignin (about 6% DM). The main factor influencing soybean forage quality is the maturity at harvest. Protein concentration decreases during flowering and increases during pod formation, while fibre concentration changes inversely. The stem and leaf proportion of the plant decreases as the pod and seed components increase. The lipid content of the mature forage can reach 10% of the DM due to the presence of oil in the seeds (Hintz *et al*., 1992).

Haulms is plant material above the ground level, harvested, dried and used forfeeding livestock. Grain legume haulms are also playing a significant role in supplying fodders for ruminant feeding in small scale mixed farming system. The highlands Ethiopia demonstrated increasing trends in the use of grain legumes haulms as livestock feed by smallholder farmers (Alkhlib *et al*., 2014). Soybean haulms (residue) have already became important components of ruminant diet in small scale mixed crop-livestock farming areas. Soybean haulms had also figured out value of 89.18, 5.10, 2.85, 96.90, 80.80, 63.20 and 13.00% for DM, CP, EE, OM, NDF, ADF and ADL contents, respectively (Maheri-Sis *et al.*, 2011).The dry matter yiled of soybean haulm was 5.31 t/ha harvested with application of NPK followed by urea fertilizer, 4.31 t/ha with organic fertilizer (compost) and 4.29 t/ha with out any fertilizer (Yagoub *et al*., 2012) and 3.23 t/ha with fertilizer in (Sisay Belete,2017).This study carried out, therefore, to select the best performing varieties, in terms of biomass yield, chemical composition, haulm yield, seed yield and other agronomic characteristics of *Glycine max* (L.)Merrill grown under the rain- fed condition of low land areas of Eastern Amhara.

Materials and Methods

Description of the study area

The study was conducted in three locations Jari, Chefa and Sirinka of Eastern Amhara. Jari is situated at $11^{0}21^{'}00^{''}$N latitude and $39^{0}38^{'}00^{''}$E longitude located at about 435 km North of Addis Ababa Capital City of Ethiopia. It lies within an altitude of 1680 meter above sea level. The area receives an average annual rain fall of 1204.6mm and a mean range temperature of 11.2-25.6 ^{0}c. There is black soil type and clay soil texture. Chefa is located at about 355 km North of Addis Ababa Capital City of Ethiopia. It lies within an altitude of 1450 meter above sea level. The area receives an average annual rain fall of 850 mm and a mean range temperature of 21-36 ^{0}c .There is black soil type and clay soil texture. Sirinka is situated at $11^{0}45^{'}00^{''}$N latitude and $39^{0}36^{'}36^{''}$E longitude located at about 508 km North of Addis Ababa Capital City of Ethiopia. It lies within an altitude of 1850 meter above sea level. The area receives an average annual rain fall of 950mm and a mean range temperature of 16-21 ^{0}c. There is Eutric soil type and clay soil texture (Adem Mohammed *et al*.,2016).

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Experimental procedures and design

The experimental fields were divided in to three blocks and the twelve treatments randomly assigned to the plots in each blocks using a randomized complete block design (RCBD). Twelve released soybean varieties were used as a treatment. Planting was done second week of July 2018 and 2019 right after the onset of the rainy season. The seeds were planted in 40 cm between rows and 10 cm between plants on a plot size of 3.2m *4m where each plots contains 8 rows and total area of the experiment was 620.6m^2. Spacing between blocks and plots were 1m and 0.5m respectively. The seed rate was 60 kg/ha. A fertilizer 100 kg/ha NPS was applied during seed planting. For estimation of biomass yield only the entire three rows were harvested at 50% of flowering stage and the remaining three rows used for seed yield and haulm yield production. Soybean varieties were Afgat ,Belesa-95, Boshe , Cheri , Dhidhessa, Gishama , Gizo, Korme, Pawe-03, katta, Wegayen and Wollo described in Table 1.

Table 1: Backgrounds of soybean varieties used as a treatment

No.	Variety Name	Year of Release/Regester	Releaser Organization/Institution
1	Afgat	2007	Awassa Agricultural Research Center (AwARC)
2	Belesa-95	2003	Areka Agricultural Research Center (ARARC)
3	Boshe	2008	Bako Agricultural Research Center (BARC)
4	Cheri	2003	Bako Agricultural Research Center(BARC)
5	Dhidhessa	2008	Bako Agricultural Research Center(BARC)
6	Gishama	2010	Pawe Agricultural Research Center (PARC)
7	Gizo	2010	Pawe Agricultural Research Center (PARC)
8	Korme	2011	Bako Agricultural Research Center(BARC)
9	Pawe-03	2016	Pawe Agricultural Research Center (PARC)
10	katta	2011	Bako Agricultural Research Center(BARC)
11	Wegayen	2010	Pawe Agricultural Research Center (PARC)
12	Wollo	2012	Sirinka Agricultural Research Center (SARC)

Source: MoANR, 2016

Data collection and statistical analysis

The varieties were harvested at 50% flowering stage and evaluated for their biomass yield (ton/ha) and chemical composition (CP, NDF, ADF, ADL and Ash). The harvested materials were dried in a forced draft oven for 72 hours at 65^{o}c till constant weight was obtained for each variety. Seed yield, haulm yield and other agronomic characteristics were collected. The data which were collected estimated to the sampled three rows and then extra polated to hectar of land. Plot coverage, vigorsity and leafiness score were collected on given lebled scoring (1-9) and biomass yield was taken when the plant reach optimum harvested stage (50% flowering) and measured fresh green weight of sample and extra pollet to hectar of land.The dry matter content was taken on the fresh green weight dryied in forced draft oven for 72 hours at 65^{o}c till constant weight and converted to sample yield to hectar yied multiplied by dry matter percentage. Ten plants were taken randomly and measured for plant height, plant height at maturity and number of pod per plant parameters. The DM, ash, nitrogen analysis, NDF, ADF and ADL were determined according to the procedure of Van Soest (1970). The data were subjected to analysis of variance (ANOVA) using Genstat computer software program and significant mean differences were separated using Duncan's multiple range test (DMRT) at 5%.

Results and Discussion

Dry matter yield and other morphological characteristics of soybean varieties

The combined mean (Table 2) showed that there was highly significant variation ($P<0.001$) between varieties in all parameters. There was significant difference ($P<0.05$) among locations in plot coverage, days to 50% flowering and biomass yield, but no significant difference ($P>0.05$) between locations under vigorsity, leafiness score, dry matter yield and plant height at 50% flowering stage. However, there was no significant difference ($P>0.05$) in variety by location interactions except days to 50% flowering which showed there was significant difference ($P<0.05$) on interaction effect.

The combined analysis across locations (Jari and Chefa) for year 2018 showed that varieties Afgat, Gizo, Pawe-03 and Wollo had higher dry matter yield as compared to other soybean varieties. The Afgat, Gishama, Gizo, Pawe-03 and Wollo varieties had higher biomass yield as

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compared to other soybean varieties. The dry matter yield of Afgat was 6.54 t/ha lowers than 7.34 t/ha reported by Suzan *et al.* (2004) and 6.72 t/ha reported by Assaeed *et al.* (2000). However, the current result was sufficient for support livestock production as the existing environment.

Table 2: The combined mean of dry matter yield and other related characteristics of soybean varieties over locations (Jari and Chefa) in 2018

Variable	N	PC	Vg	LS	DF50%	BY(t/ha)	DMY(t/ha)	PH50%(cm)
Variety	72							
Afgat	6	8.833^{a}	8.5^{a}	8.833^{a}	65.83^{c}	14.68^{a}	6.541^{a}	81.13^{ab}
Belessa-95	6	7.667^{bcde}	6.833^{d}	7.167^{c}	68.67^{b}	9.76^{de}	4.525^{de}	71.52^{cd}
Boshe	6	7.5^{cde}	7^{d}	7^{c}	62^{d}	8.43^{e}	4.646^{cde}	64.9^{e}
Cheri	6	8^{abcd}	8^{abc}	7^{c}	68.33^{b}	10.59^{cd}	5.323^{bcde}	77.16^{bc}
Dhedessaa	6	7.167^{de}	7.167^{cd}	6.833^{c}	69.67^{b}	9.07^{de}	4.29^{e}	70.28^{de}
Gishama	6	7.667^{bcde}	8.333^{a}	8.167^{ab}	69.5^{b}	12.62^{ab}	5.315^{bcde}	79.25^{ab}
Gizo	6	8.5^{abc}	8.5^{a}	8.333^{ab}	69.33^{b}	13.25^{ab}	5.879^{ab}	78.28^{ab}
Korme	6	7.833^{abcd}	7.333^{bcd}	7.167^{c}	69.33^{b}	9.03^{de}	4.5^{de}	70.91^{de}
Pawe-03	6	8.5^{abc}	8.167^{ab}	8^{b}	72.33^{a}	13.05^{ab}	5.939^{ab}	77.2^{bc}
Kata	6	6.833^{e}	7^{d}	7.167^{c}	69.33^{b}	9.46^{de}	4.266^{e}	70.61^{de}
Wogayen	6	8^{abcd}	8.5^{a}	8^{b}	65.5^{c}	12.11^{bc}	5.467^{bcd}	83.87^{a}
Wollo	6	8.667^{ab}	8.5^{a}	8.833^{a}	65.83^{c}	13.24^{ab}	5.698^{abc}	81.16^{ab}
Gmean		7.931	7.819	7.708	67.97	11.27	5.199	75.52
SEM		0.111	0.112	0.105	0.382	0.306	0.123	0.862
CV		9.6	9.4	7.8	2	14.3	15.7	6.5
SL V		***	***	***	***	***	***	***
SL LO		**	ns	ns	***	***	ns	ns
SL VX LO		ns	ns	ns	**	ns	ns	ns

***Note**: PC (%)= plot coverage; Vg= Vigorsity of plant; LS= leafiness score of plant; DF (50%)=date at 50% flowering stage; PH(50%)= plant height; BY= biomass yield; DM= dry matter yield ; N= number of observation; SEM= standard error of mean; CV= coefficient of variation; SLV= significant level of variety; SL LO= significant level of location; SL VX LO= Significant level of variety by location interaction ;ns= non significant at P> 0.05; **= significant at P<0.01; *** =significant at P<0.001; means with the same super script in columns are not significant difference*

The combined analysis of variance over two years at Jari for vigorsity, leafiness score, days to 50% flowering, biomass yield, dry matter yield and plant height at 50% flowering (Table 3) showed that there were highly significance difference (P< 0.01) between varieties but there was no significant difference (P>0.05) on plot coverage. There were significance difference (P<0.05)

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among years on leafiness score, days to 50% flowering, biomass yield, dry matter yield and plant height at 50% flowering except plot coverage and vigorsity were no significance difference (P>0.05) between years. Plot coverage, vigorsity, days to 50% flowering and plant height at 50% flowering showed that significance difference (P<0.05) on varieties by year interactions effect. However, leafiness score, biomass yield and dry matter yield had no significant difference (P>0.05) on varieties by year interaction effect. The presence of significance over varieties by year interactions indicated that there was inconsistence performance of the varieties for this character over years. However, the presence of no significance interaction indicates that the consistence performance of the variation over years.

The mean biomass yield of varieties Afgat, Gizo, Pawe-03 and Wollo were significantly higher 17.2 t/ha,16.1 t/ha, 16.7 t/ha,16.71 t/ha respectively as compared to other varieties. And also, the mean dry matter yield of varieties Afgat, Gizo, Pawe-03, Wogayen and Wollo were significantly higher 4.99 t/ha, 4.34 t/ha, 4.64 t/ha, 4.19 t/ha and 4.79 t/ha respectively as compared to other varieties. The dry matter yield of Afgat was 4.99 t/ha lowers than 7.34 t/ha reported by Suzan *et al.* (2004) and 6.72 t/ha reported by Assaeed *et al.* (2000).

Table 3: The combined mean of dry matter yield and other related characteristics of soybean varieties over years (2018 &2019) at Jari

Variable	N	PC	Vg	LS	DF50%	BY(t/ha)	DMY (t/ha)	PH50%(cm)
Variety	72							
Afgat	6	8.5	8.667[a]	8.5[a]	63.33[e]	17.2[a]	4.993[a]	71.77[a]
Belessa-95	6	8.17	7.167[cd]	7[c]	66.83[c]	9.45[c]	3.159[cd]	58.97[bc]
Boshe	6	8	7.167[cd]	7.333[bc]	60.67[f]	8.14[c]	3.026[cd]	56.75[bc]
Cheri	6	8.17	7.833[abc]	7[c]	66.5[c]	10.41[c]	3.676[bcd]	61.99[b]
Dhedessaa	6	8	7.333[cd]	7[c]	66.83[c]	9.8[c]	3.038[cd]	59.63[bc]
Gishama	6	7.5	8.167[ab]	7.667[abc]	69.17[b]	13.63[b]	3.813[bc]	69.45[a]
Gizo	6	8.5	8.5[a]	8.167[ab]	67.67[bc]	16.1[ab]	4.335[ab]	70.27[a]
Korme	6	8.17	7.333[bcd]	7.5[bc]	67.33[bc]	9.56[c]	3.364[cd]	59.19[bc]
Pawe-03	6	8.5	7.5[bcd]	7.333[bc]	74.83[a]	16.7[a]	4.635[a]	71.7[a]
Kata	6	7.67	6.667[d]	7[c]	67[c]	8.63[c]	2.888[d]	56.11[c]
Wogayen	6	8.33	8.333[a]	7.667[abc]	65.5[cd]	13.36[b]	4.189[ab]	71.77[a]
Wollo	6	9	8.667[a]	8.167[ab]	64[de]	16.71[a]	4.787[a]	74.61[a]

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Gmean		8.21	7.778	7.528	66.64	12.47	3.825	65.18
SEM		0.115	0.119	0.108	0.535	0.545	0.192	1.473
CV		10.7	8.4	9.6	2.5	18.6	16.8	6.8
SL V		ns	***	**	***	***	***	***
SL Y		ns	ns	*	***	***	***	***
SL VXY		*	*	ns	**	ns	ns	*

***Note**: PC (%)= plot coverage; Vg= Vigorsity of plant; LS= leafiness score of plant; DF (50%)=date at 50% flowering stage; PH(50%)= plant height; BY= biomass yield; DM= dry matter yield ; N= number of observation; SEM= standard error of mean; CV= coefficient of variation; SLV= significant level of variety; SL Y= significant level of year; SL VXY=Significant level of variety by year interaction; ns= non significant at P> 0.05; *=significant at P<0.05;**= significant at P<0.01; *** =significant at P<0.001; means with the same super script in columns are not significant difference*

The combined mean (Table 4) showed that there were highly significance variation (P<0.001) between varieties in all parameters. There were highly significance differences (P<0.001)) among locations in day's to50% flowering, plant height at 50% flowering, biomass yield, dry matter yield and haulm yield but no significance difference (P>0.05) between locations under vigorsity. There was significance difference (P<0.05) in variety by location interaction under vigorsity, days to 50% flowering, plant height at 50% flowering and biomass yield but dry matter and haulm yield were no significance difference (P>0.05) on interaction effect.

The combined analysis across locations showed that variety Afgat, Gishama, Gizo Pawe-03, Wogayen and Wollo were higher dry matter yield as compared to the other soybean varieties. But, there was low yield in this cropping season (2019) as compared with first year (2018) because, unfortunately, in this cropping season, there was heavy rain intensity with ice during early stage of growing at Sirinka. The dry matter yield of Pawe-03 was 2.39t/ha lowers than 7.34 t/ha reported by Suzan (2004) and 6.72 t/ha reported by Assaeed *et al.* (2000). The combined analysis across locations showed that variety Gishama (3.97 t/ha), Gizo (3.60 t/ha), Pawe-03 (4.04 t/ha) and Wogayen (3.36 t/ha) were higher haulm yield as compared to the other soybean varieties. The haulm yield of Pawe-03 (4.04 t/ha) higher than 3.23 t/ha reported by Sisay Belete (2017) but lower than 5.31 t/ha reported by Yagoub *et al.*(2012).

Table 4. The combined mean of dry matter yield and other related characteristics of soybean varieties over locations (Jari and Sirinka) 2019

Variable	N	Vg	DF	PH	BY(t/ha)	DMY(t/ha)	HY(t/ha)

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			(50%F)	(50%F)			
Variety	72						
Afgat	6	8.17^{a}	59.33^{ef}	52.07^{b}	13.08^{a}	2.19^{ab}	3.28^{bc}
Belessa-95	6	7.42^{b}	62.00^{cd}	45.73^{c}	7.19^{b}	1.41^{c}	2.29^{d}
Boshe	6	7.25^{b}	58.17^{f}	46.77^{c}	7.12^{b}	1.53^{c}	1.85^{d}
Cheri	6	7.42^{b}	61.00^{cde}	44.00^{c}	8.30^{b}	1.67^{bc}	2.38^{d}
Dhedessaa	6	7.42^{b}	60.50^{cdef}	45.13^{c}	7.81^{b}	1.52^{c}	2.09^{d}
Gishama	6	8.42^{a}	67.67^{b}	57.73^{a}	13.56^{a}	2.38^{a}	3.97^{ab}
Gizo	6	8.25^{a}	63.00^{c}	52.93^{ab}	13.34^{a}	2.08^{ab}	3.60^{abc}
Korme	6	7.25^{b}	61.17^{cde}	44.90^{c}	7.78^{b}	1.41^{c}	1.94^{d}
Pawe-03	6	7.08^{b}	75.17^{a}	52.58^{ab}	13.88^{a}	2.39^{a}	4.04^{a}
Kata	6	6.83^{b}	61.50^{cde}	42.20^{c}	6.66^{b}	1.31^{c}	2.30^{d}
Wogayen	6	8.17^{a}	61.17cde	56.87^{ab}	11.37^{a}	2.15^{ab}	3.36^{abc}
Wollo	6	8.25^{a}	60.00^{def}	55.53^{ab}	13.37^{a}	2.32^{a}	3.09^{c}
Gmean		7.66	62.56	49.70	10.29	1.86	2.85
SEM		0.10	0.6	1.12	0.69	0.11	0.13
CV		7.3	3.1	8.2	21.6	22.4	20.3
SL V		***	***	***	***	***	***
SL LO		ns	***	***	***	***	***
SL VXLO		*	*	***	***	ns	ns

Note:*Vg= Vigorsity of plantn; DF (50%)= date at 50% flowering stage; PH(50%)= plant height; BY= biomass yield; DMY= dry matter yield ; HY= haulm yield; N= number of observation; SEM= standard error of mean; CV= coefficient of variation; SLV= significant level of variety; SL LO= significant level of location; SL VX LO= Significant level of variety by location interaction ;ns= non significant at P> 0.05; *significant at P<0.05; *** significant at P<0.001; means with the same super script in columns are not significant difference*

Seed yield and other agronomic characteristics of soybean varieties

The combined mean (Table 5) showed that there was highly significant variation (P<0.001) between varieties in all parameters. There were significance difference (P<0.05) among locations in date of maturity, plant height at maturity, seed yield and thousand seed weight but no significance difference (P>0.05) between locations under number of pods per plant. There was significant difference (P<0.05) in variety by location interaction under date of maturity, plant height at maturity and thousand seed weight but number of pods per plant and seed yield were no significance difference (P>0.05) on interaction effect.

The combined analysis across locations showed that variety Pawe-03(2951 kg/ha), Gizo (2862 kg/ha), Afgat (2859 kg/ha), Gishama (2654 kg/ha),Wollo (2461 kg/ha) and Wogayen (2404

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kg/ha) had higher seed yield as compared to the other soybean varieties. The seed yield of Pawe-03 was 2951 kg/ha greater than 2609.1 kg/ha reported by Deresse *et al.* (2019).

Table 5. The combined mean of Seed yield and other agronomic characters of soybean varieties over locations (Jari and Sirinka) 2019

Variable	N	DM	PHM(cm)	NPPP	SY(kg/ha)	1000swt(gm)
Variety	72					
Afgat	6	136^{de}	59.6^{bcd}	65.3^{b}	2859^{a}	134.3^{abc}
Belessa-95	6	147.17^{abc}	69.5^{b}	38.9^{de}	1539^{bc}	137.4^{abc}
Boshe	6	129.33^{f}	54.6^{cd}	37.3^{de}	1256^{c}	94.9^{g}
Cheri	6	136.5^{de}	50.9^{d}	38.4^{de}	1337^{bc}	114.9^{ef}
Dhedessaa	6	140.33^{cd}	70.6^{b}	41.9^{de}	1406^{bc}	118.3^{de}
Gishama	6	152.5^{a}	89.1^{a}	62.1^{bc}	2654^{a}	131.1^{abcd}
Gizo	6	146.33^{abc}	67.7^{bc}	66.4^{b}	2862^{a}	139.9^{ab}
Korme	6	142.5^{bcd}	59.9^{bcd}	36.6^{de}	1465^{bc}	124^{cde}
Pawe-03	6	148.83^{ab}	71.1^{b}	88.8^{a}	2951^{a}	104.1^{fg}
Kata	6	143.5^{bc}	65.4^{bc}	35.7^{e}	1841^{b}	133.8^{abc}
Wogayen	6	147.17^{abc}	71.3^{b}	49^{cde}	2404^{a}	129.2^{bcd}
Wollo	6	131.5^{ef}	58.9^{bcd}	51^{c}	2461^{a}	145^{a}
Gmean		141.81	65.7	50.9	2086	125.6
SEM		1.17	3.02	2.26	100.6	2.21
CV		3.8	16.8	22.3	20.9	8.9
SL V		***	***	***	***	***
SL LO		***	***	ns	***	**
SL VX LO		*	***	ns	ns	*

Note: *DM= date of maturity; PHM= plant height at maturity; NPPP= number of pod per plant; SY= seed yield; swt= seed weight; N= number of observation; SEM= standard error of mean; CV= coefficient of variation; SLV= significant level of variety; SL LO= significant level of location; SL VX LO= Significant level of variety by location interaction ns= non significant at P> 0.05; *=significant at P<0.05;**= significant at P<0.01; *** =significant at P<0.001; means with the same super script in columns are not significant difference*

Chemical composition of soybean varieties

The mean nutrient composition of soybean varieties are shown in Table 6.The mean CP content range from Boshe 21.30% to Gizo 33.60%, NDF from Cheri 28.79% to Belessa-95 58.57%, ADF from Cheri 19.78% to Afgat and Belessa-95 35.16% and ADL from Cheri 4.56% to Afgat and Belessa-95 8.94% at Chefa district. The CP content Gizo is highest as compared to Boshe that means it good source of protein supplement for different production system. The NDF content of Belessa-95 was highest as compared to Cheri so it was more fibrous as compared to Cheri and other varieties. The ADF content of Afgat and Belessa-95 were highest as compared to Cheri that means Afgat and Belessa-95 had highest lingo-celulose content as compared to Cheri and other soybean varieties. The ADL content of Afgat and Belessa-95 were highest as compared to Cheri and other varieties. This indicated that Afgat and Belessa-95 had highest lignin content as compared to Cheri and other varieties. The crude protein content of Gizo (33.60%) was comparatively higher than (Craig *et al*., 1998) the mean of CP 24.5% and and 20.01% reported by Assaeed *et al.* (2000) at Chefa.

Table 6:- Chemical composition of soybean varieties (% DM basis) in 2018

Location	Chefa						
Variable		DM%	Ash %	CP %	NDF%	ADF%	ADL%
Variety	36						
Afgat	3	91	9.89	29.68	47.67	35.16	8.94
Belessa-95	3	91	10.99	24.89	58.57	35.16	8.94
Boshe	3	91	10.99	21.30	43.79	32.97	7.61
Cheri	3	91	9.89	23.20	28.79	19.78	4.56
Dhedessaa	3	90	11.11	22.23	44.44	31.11	7.77
Gishama	3	91	10.99	29.12	44.68	32.97	7.67
Gizo	3	91	9.89	33.60	44.68	32.97	8.64
Korme	3	89	11.24	24.92	46.71	33.71	8.74
Pawe-03	3	91	8.79	27.50	31.75	21.98	4.72
Kata	3	91	10.99	28.69	45.79	32.97	4.61
Wogayen	3	91	10.99	27.34	37.59	26.37	5.79
Wollo	3	94	13.83	31.60	46.82	34.04	8.64
Overall mean		91	10.80	27.01	43.44	30.77	7.47

Note: *DM= dry matter; Cp= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin*

The mean nutrient composition of soybean varieties are shown in Table 7.The mean CP content range from korme 17.20% to Wollo 35.56%, NDF from Boshe 28.79% to Belessa-95 58.57%, ADF from Wogayen 19.57% to kata 40%, ADL from Boshe 4.56% to Kata 10% at Jari. The numerical values showed that the CP content Wollo was highest as compared to others that mean it was good source of protein supplement for different production systems. The NDF content of Belessa-95 was highest as compared to other varieties so it was more fibrous as compared to

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other varieties. The ADF content of Kata was highest as compared to other varieties that mean kata had highest lingo-celulose content compared to other soybean varieties. The ADL content of Kata has highest as compared to other varieties. This indicated that Kata has highest lignin content as compared to other varieties. The variety kata could not easily digested and absorbed by animals that were relatively high in crude fiber and low in total digestible nutrients and protein.

The mean CP content range from korme 14.59% to Wollo 27.66%, NDF from Wollo 40.8% to Belessa-95 56.14%, ADF from Wollo 24.74% to Gishama 35.05%, ADL from Gizo and Wollo 7.27 % to Gishama and Korme 9.1% at Sirinka. The numerical value showed that the CP content of Wollo was highest as compared to others that mean it was good source of protein supplement for different production system.This indicated that variety Wollo could be had high crude protein content and digestable nutrients can support animal production over maintenance requirement of animals. It was used as supplementation of roughag feed sources used as animal feed. The NDF content of Belessa-95 was highest as compared to other varieties so it was more fibrous as compared to other varieties. The ADF content of Gishama was highest as compared to other varieties that mean Gishama had highest lingo-celulose content as compared to other soybean varieties. The ADL content of Gishama and Korme were highest as compared to other varieties. This indicated that Gishama and korme had highest lignin contents as compared to other varieties.

The crude protein content of variety Wollo 35.56%, 27.66% at Jari and Sirinka respectively was comparatively higher than (Craig *et al*., 1998) the mean of CP 24.5%, 20.01% reported by Assaeed *et al.* (2000). Therefore, it possible to generalize that all varieties in all three locations used as protein supplement for growing and lactating animals where soybean varieties can be accessible to producers.

Table 7:- Chemical composition of soybean varieties (% DM basis) in 2019

Location	Jari							Sirinka						
Variable		DM %	Ash %	CP %	NDF %	ADF %	ADL %		DM %	Ash %	CP %	NDF %	ADF %	ADL %
Variety	36							36						

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Afgat	3	91	10.99	32.46	41.35	30.77	7.67	3	96	10.42	26.56	44.32	27.08	7.32
Belessa-95	3	91	10.99	20.98	58.57	35.16	8.94	3	96	6.25	18.09	56.14	31.25	8.74
Boshe	3	91	9.89	18.8	28.79	19.78	4.56	3	97	12.37	17.81	45.38	28.87	8.12
Cheri	3	90	10	20.12	33.33	22.22	5.55	3	97	12.37	17.88	45.38	28.87	8.15
Dhedessaa	3	91	9.89	17.68	44.68	32.97	8.64	3	95	12.63	20.31	45	29.47	8.64
Gishama	3	91	10.99	29.24	43.59	32.97	7.67	3	97	11.34	23.06	55.62	35.05	9.1
Gizo	3	91	9.89	23.4	47.39	35.16	8.94	3	97	10.93	26.03	44.29	26.80	7.27
Korme	3	91	9.89	17.2	42.15	30.77	7.67	3	96	12.50	14.59	50.2	33.33	9.1
Pawe-03	3	91	10.99	30.49	50	39.56	9.82	3	97	11.34	25.09	50.15	32.99	8.4
Kata	3	90	11.11	20.4	52.22	40	10	3	97	13.40	18.53	45.5	30.93	8.31
Wogayen	3	92	9.78	27.63	30.24	19.57	4.68	3	97	11.34	18.13	45.38	28.87	8.15
Wollo	3	91	9.89	35.56	45.75	32.97	7.61	3	97	11.34	27.66	40.8	24.74	7.27
Overall mean		91	10.36	24.5	43.17	30.99	7.65		96.58	13.02	21.15	47.35	29.85	8.21

Note: *DM= dry matter; Cp= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin*

Conclusion and Recommendation

The result indicated that there were significance difference among soybean varieties for dry matter yield, haulm yield, seed yield and other agronomic traits. The varieties in their combined analysis showed that Afgat, Pawe-03 and Wollo gave better in most of important parameters than other varieties. The CP content of all varieties had above the optimal level to use as protein supplement in livestock nutrition. Specifically Wollo and Gizo varieties gave higher crude protein content in three locations than others. The crude protein content of such varieties indicated that these species can be used as supplementary feed for livestock production. Therefore, Afgat, Pawe-03 and Wollo recommends for the given areas of Jari , Chefa, Sirinka and could be produced in similar environment for the beast of produced optimal amount of dry matter, haulm and seed yield as forage of high quality and good protein supplement for growth and production of ruminant. Thus, further research is needed to investigate on the utilization of livestock and varieties response on production.

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