



## Participatory Variety Selection of Potato (*Solanum tuberosum* L) Varieties at Wondo Genet and Wondo Woredas

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**Abstract:** The experiment was conducted during 2019 and 2020 growing seasons at wondogenet and wondo. Six potato varieties were tested using randomized complete block design with three replications using mother-baby trial approach. All necessarily data were collected from the mother trial and analyzed using SAS software and SPSS. The combined analysis of variance showed the presence of significant differences ( $p \leq 0.05$ ) among tested varieties for plant height, tuber diameter and tuber yield per hectare. The highest tuber weight per plant was harvested from Gudane variety (1.68) which was statistically similar with Jalene (1.49) variety but Dagim variety was gave the lowest (0.30) which was statistically similar with Gera (0.75) variety. Gudane variety gave the highest tuber yield per hectare (33.67) which had no statistically difference with the yield obtained from Jalene variety (30.67) while the lowest (14.05) was recorded from Dagim variety. The participated farmers have given a rank for the traits used for selection and evaluated the varieties using their own selection criterias. As a result, based on their preferences Gudane, Jalene and Guassa varieties were selected as the first, second and third choices. Therefore, scaling up of these selected varieties should be done in the study area and areas with similar agroecologies so that producers can able to access the variety to the farmers resulted in overcoming food insecurity.

**Keywords:** Baby trial, Farmer preferences, Mother Trial, Tuber yield, Selection.

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## 1. INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to the *Solanaceae* family and genus *Solanum*. The genus *Solanum* is a polymorphous and largely tropical and subtropical genus containing more than 1000 species (Spooner and Knapp, 2013). Potato is a crop of major economic importance worldwide. It is the fourth most important crop after rice, wheat, and maize, and has historically contributed to food and nutrition security in the world (FAOSTAT, 2015; FAO, 2015). It is playing a major role in national food and nutrition security, alleviation of poverty, generating income, and providing job opportunity in line with production, processing and marketing sub-sectors (Lung'aho *et al.*, 2007). Potato has very good

nutritional importance and it can produce more energy and protein per unit and area per unit time than most other major cereal food crops; it is fat-free and contains substantial amounts of minerals (Lutaladio and Castaldi, 2009). The crop is also rich in several micronutrients and vitamins, especially vitamin C; a single medium sized potato of 150 g provides nearly half of the daily adult requirement (100 mg) (FAO, 2008). It is a high potential food security crop in Ethiopia due to its high yield potential, nutritional quality, short growing period and wider adaptability (Tewodros *et al.*, 2014).

According to Gebremedhin *et al.*, (2008a), the major potential areas for potato production are the Central, Southern, Southeastern, Southwestern

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and Northwestern part the country, where altitude ranges from 1500 to 3000 m and the rainfall between 600 to 1200 mm. Even though Ethiopia has so suitable environment for potato production, the national average yield is very low (13.8 t/ha) which is lower the world average yield of 19 t ha<sup>-1</sup> (CSA, 2017). The low productivity is attributed due to lack of well adapted varieties which is accepted by the farmers, unavailability and high cost of seed tubers, too low or too high planting density, diseases, insect, etc (Bereke, 1994; Gebremedhin *et al.*, 2008; Adane *et al.*, 2010).

Wider adaptation and researchers' criteria may not fit to all agro ecologies and fulfill farmer's preferences. Agro-ecologies varied with respect to soil type, moisture and temperature regimes, fertility condition and the onset, intensity and duration of rain as well as irrigation facilities, where farmers thrive to grow potato (Gebremedhin *et al.*, 2008). Heterogeneous environment, large diversity of farmer's needs, lack of adapted varieties to those diverse agro ecologies facing the formal breeding methods and often fails to meet the needs of farmers and to develop cultivars or varieties showing specific or local adaptation (Desclaux, 2005). That is why most technologies developed without farmers' participation have failed to address the issues of rural poverty appropriately (Pretty *et al.*, 1985).

Participatory Variety Selection (PVS) can effectively used to identify farmer-acceptable varieties and thereby overcome the constraints that cause farmers to grow old or obsolete varieties (Witcombe *et al.*, 1996). Moreover, participatory research complements the formal breeding system (Belay *et al.*, 2006), increases the job efficiency of the researchers (Bellon, 2001) and farmers' knowledge that enables to be retained effectively from year to year (Grisley and Shamambo, 1993). PVS is a more rapid and cost-effective way of identifying farmer-preferred cultivars if a suitable choice of cultivars exists (Witcombe *et al.*, 2008). In many parts of Ethiopia particularly at Wondo Genet and Wondo areas, farmers grow old varieties, which resulted in farmers for highly demanding of better yielding, and disease resistant varieties of potato. Therefore, participatory Varietal Selection (PVS) has proposed as a solution to evaluate and select the best adaptable, high yielder and disease resistant varieties of potato through farmer's selection preferences and to diversify and popularize this economically important plant in the study areas

## 2. MATERIALS AND METHODS

### 2.1. Description of Experimental Site

Based on preliminary survey, two potatoes producing kebeles were selected in Wondo genet and Wondo woredas, which represents similar

farming systems but have different agro-ecologies and get the access to nearest main markets of Hawassa and Shashemene. Wondo genet is situated in Sidama region at the elevation of 1780 m.a.s.l with the minimum and maximum temperature of 12.02°C-26.72°C and 1128 mm average annual rainfall, respectively. The soil category of the area is a sandy loam type, which is favorable for potato production. Also, Wondo is found in west arsi zone of Oromia region at the elevation of 1824 m.a.s.l with the average temperature of 17.1 °C and receives an average annual rain fall of 1000 mm, respectively. The soil category of the area is sandy loam type, which is favorable for the growth of potato. The farmer growers of both districts commonly produce the potato for market purposes and for home consumption in the meher season.

### 2.2. Experimental Design and Field Management

The experiment consisted of six potato varieties (Gera, Guassa, Dagim, Belete, Jalene, Gudane), which released by different research center. The experiment was carried out as Mother and Baby trials. The mother trial was arranged in randomized complete block design (RCBD) with three replications. Thus, there was six treatments in triplicates. The treatments were randomly allotted to each plot. The experimental plot had an area of 8.64 m<sup>2</sup> (2.70m length x 3.20 m width). The space between replications and plots was 1.5 m and 1 m, respectively. The space between rows and plants was 70cm and 30cm respectively. Fertilizer rate as recommended by research center (195 kg TSP/ha and 165 Urea /ha) was be applied. Urea fertilizer also applied in split that is 50% during time of planting and the rest 50% urea was applied at vegetative stage while all TSP fertilizer was applied at time of planting. Plants in the three middle rows out of the five rows per plot constituted the net plot used as the sampling unit. Five plants from the middle rows were taken for sampling and for growth parameters and the yield was obtained from the harvestable area of the middle three rows and converted to hectare.

### 2.3. Farmers Preferences for Varieties Evaluation

Participatory variety selection was used in this research to identify farmers' selection criteria and acceptable varieties to adopt and assimilate into the production system. Selection of varieties was done in research stations at wondogenet and wondo. Researchers, experts from woredas and kebeles agricultural development office and farmers were participated on selection of potato varieties. A total of about 36 (females and males) participants were participated of which 26 of them were farmers (F=7, male =19), 4 DA (F=2 and M= 2) and 6 experts (F=1 and M=5). Before

evaluation of varieties, discussions on plant characters were made with invited farmers and the farmers provided their opinion on the preferred attributes and identified the traits such as tuber size, tuber color, tuber uniformity, diseases resistance/tolerance, earliness to maturity, tuber yield and taste. Two phases of selection ways were conducted in the field day. The first was to select varieties through observing at flowering stage and the second was through observing the yields/tubers harvested from each variety based on farmer's preferences/criteria. In general, according to agronomic data and farmer preference criteria like disease resistant, high yielder, larger tuber size, good color and high number of tubers and good taste had considered as the variety had a good trait to be selected by farmers.

#### 2.4. Data analysis

Collected data were subjected to analysis of variance using SAS package (SAS 9.4). Least significance differences (LSD) were made to compare the treatments following the procedures of Gomez and Gomez (1984). Farmers' perception data was analyzed using SPSS software.

### 3. RESULT AND DISCUSSIONS

#### 3.1. Growth and Yield traits of Potato

The analysis of variance (ANOVA) revealed significant ( $P \leq 0.01$ ) difference among the varieties for plant height, tuber diameter, tuber weight/plant and tuber yield per hectare but no significance differences have been observed for tiller number and tuber number. Guassa variety was the tallest (196.93cm) which was statistically similar with Jalene and Gudane varieties and the shortest was Dagim (92.52cm). As far as tuber diameter is concerned, the maximum tuber diameter (8.07cm) was obtained from Belete variety which was statistically similar from the value obtained from Gudane, Guassa and Jalene varieties while the lowest (4.82cm) was from Dagim variety (Table 1). The differences among varieties for agronomic and yield traits, indicated the presence of sufficient variability, which could be attributed to the genetic potential of the varieties used among the evaluated varieties and for the traits under consideration. This result is in agreement with similar findings in potato varieties tested in different areas (Zewdu *et al.*, 2017) and in tomato (Mehadi *et al.*, 2016). Similarly, Abebe *et al.* (2021) observed significance differences among potato genotypes for different growth and yield traits.

**Table 1: Combined mean values for different traits of tested potato varieties in two districts in 2019/20 main cropping season**

Varieties	Plant height (cm)	Tiller numbers/plant	Tuber diameter (cm)	Tuber numbers/plant
Jalene	184.20 <sup>ab</sup>	3.33 <sup>a</sup>	6.46 <sup>b</sup>	13.93 <sup>a</sup>
Gudane	176.00 <sup>ab</sup>	3.20 <sup>a</sup>	7.46 <sup>ab</sup>	14.73 <sup>a</sup>
Belete	151.53 <sup>c</sup>	2.87 <sup>a</sup>	8.07 <sup>a</sup>	12.87 <sup>a</sup>
Dagim	92.52 <sup>d</sup>	1.86 <sup>a</sup>	4.82 <sup>c</sup>	6.60 <sup>b</sup>
Gera	172.00 <sup>bc</sup>	2.13 <sup>a</sup>	6.35 <sup>b</sup>	13.51 <sup>a</sup>
Guassa	196.93 <sup>a</sup>	3.00 <sup>a</sup>	7.19 <sup>ab</sup>	16.00 <sup>a</sup>
CV	7.97	16.09	12.15	21.57
LSD	23.52	1.60	1.49	6.00

The highest tuber weight per plant was harvested from Gudane variety (1.68) which was statistically similar with Jalene (1.49) variety but Dagim variety was gave the lowest (0.30) which was statistically similar with Gera (0.75) variety. Gudane variety gave the highest tuber yield per hectare (33.67) which had no statistically difference with the yield obtained from Jalene variety (30.67) while the lowest (14.05) was recorded from Dagim variety. The presence of highly significant differences among potato varieties for tuber yield might be the due to the presence of genetic differences used in the development of these varieties. Tessema *et al.*, (2020) also reported that potato varieties had a significance difference with respect to tuber and tuber related traits. Moreover, Habtamu *et al.*, (2016) and Abebe *et al.*, (2021) also reported a similar result in which significance differences

among potato varieties was found probably due to genetic variability presented.

**Table 2: Combined mean values for different traits of tested potato varieties in two districts in 2019/20 main cropping season**

Varieties	Tuber weight/plant (kg)	Tuber yield/hectare (t/ha)
Jalene	1.49 <sup>ab</sup>	30.67 <sup>ab</sup>
Gudane	1.68 <sup>a</sup>	33.67 <sup>a</sup>
Belete	1.22 <sup>c</sup>	23.49 <sup>c</sup>
Dagim	0.30 <sup>d</sup>	14.05 <sup>d</sup>
Gera	0.75 <sup>d</sup>	16.03 <sup>d</sup>
Guassa	1.27 <sup>bc</sup>	25.81 <sup>bc</sup>
CV	13.98	13.98
LSD	0.60	14.13



### 3.2. Participatory Variety Selection of Potato Varieties

Yield and quality traits are played an important part in the successful production and marketing of potato. However, traditionally, high yielding ability alone was the most important factor to the producer but there should be other additional traits which should be considered in variety evaluation. For instance, from participatory variety selection, in the two sites wondogenet and wondo the best quality taste, disease resistant, highest yielder, tuber

number, marketable tuber size, tuber uniformity and tuber color scored high percent response rate in farmers evaluation, which were ranked as 1st, 2nd and up to 7<sup>th</sup> (Table 4). Therefore, the participated farmers have given a rank for the traits used for selection and evaluated the varieties using their own selection criterias. As a result, based on their preferences Gudane, Jalene and Guassa varieties were selected as the 1st, 2nd and 3rd choices (Table 3) while the other varieties were low yielder and low-quality taste, selected less by the farmers in the study area.



Figure 1: Evaluation of Potato varieties with integration of farmers and Agricultural experts at flowering and harvesting stages

Table 3: Farmers preferences for potato varieties at both testing locations in 2019/2020

Preferences Criteria	Rank 1-5					
	Jalene	Gudane	Belete	Dagim	Gera	Guassa
Earliness	2	2	1	1	3	3
Disease resistance	1	1	2	5	2	2
No. of tiller/plant	1	1	1	4	2	1
No. of tubers/plant	1	1	2	3	2	1
Yield	2	1	3	5	3	1
Tuber size	1	1	4	4	3	2
Tuber color	1	1	1	1	1	1
Tuber uniformity	2	2	2	3	2	4
<b>Rank sum</b>	<b>11</b>	<b>10</b>	<b>16</b>	<b>26</b>	<b>18</b>	<b>15</b>
<b>Overall rank</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>6</b>	<b>5</b>	<b>3</b>

Table 4: Pairwise ranking matrix for traits of potato varieties at both sites

Traits	TN	DR	TY	TS	TC	TU	TA	Total	Rank
TN		DR	TY	TN	TN	TN	TA	3	4
DR			DR	DR	DR	DR	TA	5	2
TY				TY	TY	TY	TA	4	3
TS					TS	TS	TA	2	5
TC						TU	TA	0	7
TU							TA	1	6
TA								6	1

TN= Tuber number, DR= Disease resistant, TY= Tuber yield, TS= Tuber size, TC= Tuber color, TU= Tuber uniformity, TA= Taste

#### 4. SUMMARY AND CONCLUSION

Potato is a rich source of carbohydrates and also contains significant amounts of proteins, minerals, vitamins, micronutrients, and phytonutrients, including antioxidants as well as dietary fiber. Therefore, enhancing the productivity of this crop may be a key tool in fulfilling the nutritional requirements of the rising global population including Ethiopia. In order to respond to an increasing demand of this crop, participatory variety selection trial was conducted with the objective of selecting the best performed and preferred varieties with farmer's preferred traits. The combined analysis of variance showed the presence of significant differences ( $p \leq 0.05$ ) among tested varieties for plant height, tuber diameter and tuber yield/ha. The highest tuber yield was obtained from Gudane, which was statistically similar with Jalene, followed by Guassa while Dagim variety gave the lowest tuber yield as compared to the others. The participated farmers have given a rank for the traits used for selection and evaluated the varieties using their own selection criterias. As a result, based on their preferences the three best performed and selected varieties were Gudane, Jalene and Guassa, selected as the 1st, 2nd and 3rd choices. Therefore, scaling up of these selected varieties should be done in the study area and areas with similar agroecologies so that producers can able to access the variety to the farmers resulted in overcoming food insecurity.

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#### REFERENCES

- Abebe, C., Gebremedhin, W., Egata, S., Kasaye, N., Tesfaye, A., Alemu, W., & Fikadu, G. (2021). Evaluation of Advanced Potato (*Solanum tuberosum* L.) Clones for High Tuber yield and Processing Quality in Central Highlands of Ethiopia.
- Adane H., Meuwissen, M. P., Tesfaye, A., Lommen, W. J., Lansink, A. O., Tsegaye, A., & Struik, P. C. (2010). Analysis of seed potato systems in Ethiopia. *American journal of potato research*, 87(6), 537-552.
- Belay, G., Tefera, H., Tadesse, B., Metaferia, G., Jarra, D., & Tadesse, T. (2006). Participatory variety selection in the Ethiopian cereal tef (*Eragrostis tef*). *Experimental Agriculture*, 42(1), pp.91101. Available at: [http://journals.cambridge.org/abstract\\_S0014479705003108](http://journals.cambridge.org/abstract_S0014479705003108) [Accessed December 03, 2018].
- Bellon, M. R. (2001). Participatory Research Methods for Technology Evaluation. A Manual for Scientist Working with Farmers. Mexico, D. F. CIMMYT, pp. 93.
- Bereke, T. T. (1994). The utilization of true potato seed (TPS) as an alternative method of potato production. Ph.D. thesis, Wageningen, The Netherlands.
- CSA (The Federal Democratic Republic of Ethiopia Central, Statistical Agency). (2017). Agricultural sample survey on crop and livestock product utilization. Volume VII Addis Abeba, Ethiopia. pp. 11-97.
- Desclaux, D. (2005). Participatory Plant Breeding Methods for Organic Cereals. In: Lammerts Van Bueren, E. T., & Ostergard, H. (Eds.) *Proceedings of the COST SUSVAR/ECO-PB Workshop on Organic Plant Breeding Strategies and the Use of Molecular Markers*, pp. 17-23.
- Gebremedhin, W., Endale, G., & Lemaga, B. (2008a). Potato variety development. In Root and tuber crops: The untapped resources, ed. GebreGebremedhin, W., Endale, G., Lemaga, B. 15–32. Addis Ababa: Ethiopian Institute of Agricultural Research. germplasm using RAPD markers. *Crop Sci*, 38, 1348-1355.
- Grisley, W., & Shamambo, M. (1993). An analysis of the adoption and diffusion of carioca beans in Zambia resulting from an experimental distribution of seed. *Experimental Agriculture*, 29(3), 379-386.
- Gebreselassie, H., Wahassu, M., & Shimelis, B. (2016). Evaluation of potato (*Solanum tuberosum* L.) varieties for yield and yield components in Eastern Ethiopia. *Evaluation*, 6(5).
- Mehadi, S., Beriso, M., & Worku, Y. (2016). Participatory variety selection of improved tomato (*Lycopersicum esculentum* Mill.) varieties in the lowlands of Bale, South-Eastern Ethiopia. *African Journal of Agricultural Economics and Rural Development ISSN*, 4(7), 458-462.
- Nkongolo, K. K., Chinthu, K. K. L., Malusi, M., & Vokhiwa, Z. (2008). Participatory variety selection and characterization of Sorghum (*Sorghum bicolor* (L.) Moench) elite accessions from Malawian gene pool using farmer and breeder knowledge. *African Journal of Agricultural Research*, 3(4), 273-283.

- Pretty, J. N., Guijt, I., Thompson, J., & Scoones, I. (1985). A Trainer's Guide for Participatory Learning and Action. IIED Participatory Methodology Series. London: IIED (HT2700 PRE) p. 54-71.
- Tessema, L., Mohammed, W., & Abebe, T. (2020). Evaluation of Potato (*Solanum tuberosum* L.) Varieties for Yield and Some Agronomic Traits. *Open Agriculture*, 5(1), 63-74.
- Ayalew, T., Struik, P. C., & Hirpa, A. (2014). Characterization of seed potato (*Solanum tuberosum* L.) storage, pre-planting treatment and marketing systems in Ethiopia: The case of West-Arsi Zone. *African journal of agricultural research*, 9(15), 1218-1226.
- Witcombe, J. R., Joshi, A., Joshi, K. D., & Sthapit, B. R. (1996). Farmer participatory crop improvement. I. Varietal selection and breeding methods and their impact on biodiversity. *Experimental agriculture*, 32(4), 445-460.
- Witcombe, J. R., Joshi, A., Joshi, K. D., & Sthapit, B. R. (1996). Farmer participatory crop improvement. I. Varietal selection and breeding methods and their impact on biodiversity. *Experimental agriculture*, 32(4), 445-460.
- Zewdu, A., Aseffa, G., Girma, S., & Benga, C. (2017). Participatory Evaluation and Selection of Improved Irish Potato Varieties at Daro Lebu and Oda Bultum Districts of Western Hararghe Zone, Oromia Regional State, Ethiopia. *Bioinformatics*, 5(6), 82-89.