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Participatory variety selection for enhanced promotion and adoption of improved potato (*Solanum tuberosum* L.) varieties in Southwest Ethiopia

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Abstract

Participatory variety selection is an approach which provides a wide choice of varieties to farmers to evaluate in a given varieties for their own environment to increase production. It enhances farmers' access to diverse crop varieties, increases production and ensures food security and helps faster dissemination and adoption of released varieties. It allows varietal selection in targeted areas at cost-effective and timely manner and helps promotion of community seed production and seed banks. This experiment was designed to conduct potato participatory variety evaluation and selection at southwestern Ethiopia on farmers' farm land to overcome production problem supplying three newly released potato varieties namely; Belete, Gera and Shankala. At different locations, each variety performed differently. Accordingly, farmers selected according to their performance in their areas setting growth habit, stem thickness, maturity period and disease tolerance as main selection criteria. Therefore, a variety developed through participatory variety selection usually meets the demand of different stakeholders. Besides, from the experiment, the main bottleneck in potato production was identified to be lack of technology supply and extension besides of participatory evaluation and selection. So, it calls researchers to participate users while variety development and technologies extension.

Keywords*:* Farmers adoption, Participants, Potato varieties, Selection criteria.

Introduction

Root and tuber crops are the main sources of food for majority of poorest people in developing countries of sub-Saharan Africa. The crops provide considerable amount of yield on infertile poor soil where other crops do not. The main root and tuber crops grown in most Sub-Saharan Africa are cassava, potato, sweet potato, taro and yam. The ease of cultivation and nutritive value of these crops made them expansion in production [1];[3]. The other main uses of these crops are sources of industrial input for starch sources and alcoholic beverage, as stew in food, cheeps, as feed and food source and seed materials [1].

In Ethiopia, these crops including enset predominantly produced in Southern and Southwestern parts. Of these, Irish potato is an important root and tuber crops cultivated in almost all farmers of Ethiopia being consumed daily by millions of people. The crop grow in wider ranges of agro-ecologies though the current achievement indicated the declining in area of production due to over population and urbanization [3]. Besides, the low soil fertility is the most important constraints limiting potato production in east Africa [2]. These enforce producers to use new potato technologies with full packages just to boost yield per piece of land.

Through years, more than 25 potatoes varieties were released for production for different agro-ecologies of Ethiopia. These varieties were selected based on major criteria like yield potential, tolerant to blight, earliness in maturity period and wider adaptability [3].

In Southwestern part of Ethiopia, potato produced for consumption and for market purposes as sources of cash crop. The agro-ecological areas, irrigation availability and demand of the produces are the major factor of production which promotes its production [4]. Many efforts exerted in developing new potato technologies by different institutions and scholars and a lot of technologies were advanced. But, way of technologies advancement consider variety adaptability, tolerance/resistance to biotic and abiotic factors, yield and maturity period. However, the production and productivities yet are not satisfactory. The main factors contributed to low yield are lack of availability of advanced technologies to producers, adoption level of recommended varieties to specific location and lack of promoting the technologies.

In most of research work where involvement of stakeholders ignored, no expected goals achieved. Because, understanding farmers' choices across different agro-ecological growing areas are

paramount for who seek to develop acceptable technologies, identifying and understanding farmers' preference criteria. Additionally, it is the beginning steps in breeding; participating gender and including local growing habit or variety [3].

In southwestern Ethiopia, farmers cultivate potatoes buying the sources of seed from market which resulted disease devastation. Additionally, no practices of using modified agronomic practices used by farmers. So that, no adequate and potential yield recorded to satisfy the demand of the crop. Cognizant to these factors, this experiment was conducted with the objectives: to evaluate and select best variety/ies based on farmers' preferences criteria and to supply healthy and improved potato materials for farmers.

Materials and Methods

Experimental materials, locations and design: Three released Irish potato varieties were brought from Debre Brahan Agricultural Research Center and used as experimental materials. These include Belete, Gera and Shankala.

The experiment was conducted during cropping season of 2019/20 in Illu Ababora zone (at Metu research trial site of Jimma Agricultural Research center) and Jimma zone on two farmers' farm land (at Somodo and Sombo). At Somodo, farmers' training centers (FTC) was selected where altitude of the site is more than 1900 m.a.s.l while one farm site of youth association was selected who were associate and produce potato for market purpose in Sombo with altitude of 1950 m.a.s.l. These locations were selected based on their agro-ecological suitability for potato production and irrigation water availability. The altitude of all locations where the trial conducted was above 1500m.a.s.l. The experiment was laid out in single plot design with plot size of 3x4 ($12m^2$) for each variety at each location considering farmers/locations as replication (baby trial) in different districts. The experiment was conducted during dry period using irrigation and hand watering.

Experimental procedures and method of data collection: From the starting point of site selection, land preparation and planting to harvesting, surrounding farmers of the trial site were participated. At planting, using the potato materials prepared for this experiment, agronomic practices they applied locally such as weeding, spacing (1mx1m), earthing up frequency in line with recommended spacing of 30cmx75cm intra and inter raw spacing and weed management was applied side by side. Meanwhile, evaluation and selection of well performing varieties were done twice: at vegetative stage and during harvesting being with them.

Data were collected based on farmers' selection criteria. Different farmers' selection criteria were recorded and participants grouped in to two to three groups, numbers of farmers selected which variety and selection criteria were recorded. Additionally, yield data of each variety, tuber size, shape and color was assessed and weighted. Besides, based on conventional cultivation they used and the improved agronomic practices, comparisons of yield achieved were done. Data analysis was done using pairwise comparison method.

Results and Discussion

Farmers' variety selection criteria: Different selecting criteria were mentioned by the participants in the study areas. These include disease and insect pest tolerance, maturity period, vigor and tiller development habit as well as yield performance (tuber size, shape and color). In the study areas, farmers select late maturing, vigor and thick stem potato varieties with more tiller at all locations. Additionally, varieties which showed disease symptom and early flowered were highly neglected by farmers. Only few farmers selected early maturing variety for filling food gap during shortage of other crops. As a matter of chance, for the criteria set, these three varieties varied. Based on these, result of participants selected and ranked put as in table 1 below. Based on these criteria, at Metu and Sombo, Belete and Gera ranked first and second at vegetative stage. At Somodo, variety Gera and Shankala selected and ranked first and second based on vegetative attributes (table 1). Accordingly, based on maturity period, the early maturing variety was selected only for its earliness to fill the food gap. Otherwise, they suggested the late maturing varieties expected to provide high yielder. Additionally, these late maturing types had good vigor habit, thick stem, more tiller and lately flowering characters. They took such traits as indicator of high yielding habit (table 2). At all locations, the ideas, suggestion and the view participants had almost similar but, performances of each variety varied from location to location. This result was in parity with the achievement of [5] who suggested farmers' varieties preference differ at different locations based on their selection criteria.

Additionally, at all locations, disease and insect pest tolerance and yield performance were the main criteria of potato selection used while maturity period, vigor, stem thickness and tillering were also the most crucial yield determinant factors (table 1). Performance of certain variety differs from location to location. For example, variety Gera provided highest yield than others only at Somodo trial site while Belete performed

best at Sombo and Somodo. However, no varieties fulfill all settled criteria (Table 2).

Table 1. The summary of selection criteria and number of participants ranking varieties in each location

T.No.	Farmers' criteria	Varieties			Rank of
		Belete	Shanakala	Gera	criteria
1	Tiller and vigour	19	6	17	4
2	Tolerant to disease and insect	22	10	13	1
3	Lateness in maturity	14	13	18	3
4	Tuber size, shape and color	12	15	20	5
5	High yield	20	10	15	2
Score		87	54	83	-
Rank		1	3	2	-

At Metu based on disease and pest tolerant, tiller development, vigor, yield and related traits, Belete and Shankala varieties ranked first and second respectively. On the other hand, the same varieties ranked second for its early maturity whilst variety Gera preferred at Somodo in all set parameters followed by Shankala variety. Similarly, at Sombo, Belete variety acquired most selectors as it performed best. However, Shankala variety ranked third due to its poor performance than other varieties T this location (table 2).

Table 2. The summary of selection criteria and the rank of varieties in each location

T. No.	Farmers' criteria	Metu			Sombo			Somodo		
		Belete	Shankala	Gera	Belete	Shankala	Gera	Belete	Shankala	Gera
1	Tiller and vigour	1	3	1	2	3	1	3	2	1
2	Tolerant to disease and insect	1	3	2	1	1	1	1	1	1
3	Lateness in maturity	2	2	1	2	2	1	3	2	1
4	Tuber size, shape and color	1	2	3	1	2	2	3	2	1
5	Yield	1	3	2	1	2	1	3	2	1

The second phase of evaluation was done during harvesting, where yield of each variety weighted, the size and shapes of tubers were considered by farmers.

According to collected data at Metu variety Belete provided the largest yield followed by Gera 13.16 t/ha and 12.8 t/ha respectively whereas the lowest yielder was Shankala with 12.36t/ha respectively. Similarly, the same variety Belete was gave highest yield of 32.44 t/ha at Sombo and the rest two varieties provided equal marketable yield weight of 28.44 t/ha. At Somodo, but, the variety Gera observed to be top yielder of 36 t/ha followed by Shankala 33.78t/ha. At this location Belete gave the least 27.56 t/ha in reverse to the other locations.

Table 2. The summary of yield performance of the three varieties at the three locations for cropping season of 2011 E.C

Location	Varieties	Tuber no./plant	Mark no./plot	Mark. Wt/ha (ton/ha)
Metu	Belete	5	213	13.16
	Gera	7.2	301	12.8
	Shankala	4.5	224	12.36
Sombo	Belete	6.9	333	32.44
	Gera	5.7	300	28.44
	Shankala	4.5	302	28.44
Somodo	Belete	7.2	260	27.56
	Gera	10.57	460	36.00
	Shankala	8.125	327	33.78

Figure 1. Photo taken during participating farmers at vegetative and harvesting

During experiment, in variety selection, the criteria considered by farmers and other stake holder differ from researchers' point of view. Most farmers considered and preferred more vigor but late mature at vegetative, marketable sized tubers but very large sized and under sized tubers ignored. Because, few of very large sized tubers weight kilogram. Besides, the shape, color and diseases reaction also taken in to account as selection criteria. At different trial site, the performance and yield of each variety vary which was supported by the statement of Wolie and Fentie (2017) who portrayed that the grain yield of different varieties at different locations vary being base of selection criteria. So, based on vegetative and yield based, at Metu, varieties Belete and Gera were ranked first and second whereas at Somodo Gera and Shankala prioritized first and second. But, at Sombo, Belete had chosen to be best performing variety.

Conclusion

In varieties selections different criteria considered by farmers which mostly matched researchers' selection criteria. Additionally, different varieties performed differently at different locations. The main considered criteria by farmers were vigor, resistant with late maturing. So, the probabilities of one variety to be selected at different locations

depend on the performance it observed at that location and fulfill producers' criteria. Based on these, at Sombo and Metu locations variety Belete ranked first while Gera and Shankala ranked 2nd and 3rd respectively. However at Somodo, Gera variety showed the best vegetative and yield performance and ranked first. Generally, this experiment was done up to yield but not evaluated at cooking stage since cooking quality is the main factor at consumption level. So, the future experiment and variety development should touch farmers' evaluation criteria to increase adoption level from the stage of vegetative to consumption so that promotion of the technologies will be easy.

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