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TOWARDS FARMERS' PARTICIPATORY RESEARCH:

Attempts and Achievements in the Central Highlands of Ethiopia



**Ethiopian Agricultural Research Organization
(EARO)**



On -Farm Evaluation of Potato Varieties in West and Northwest Shewa Zones

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Summary

Potato plays a great role as a household food security and cash crop for many families in Ethiopia. However, lack of suitable varieties with desirable character has limited the productivity and expansion of the crop. To address this problem, two on-farm variety trials were conducted: the first in two districts, (Galessa & Meta Robi), at altitudes of 2950 and 2530 m.a.s.l, respectively, in 1999-2000 and the second in 7 districts at 28 villages in the year 2000. The objectives were to encourage farmers to participate in the evaluation and selection of varieties that would satisfy their needs and expectations; assess the performance of advanced and released varieties under farmers cropping systems; and understand attributes desired by farmers so as to establish feed back flow among researchers, extensionists and farmers in order to maximize selection efficiency. The experiments were laid out in a randomized complete block design (RCBD).

Results of the first trial in relation to yield performance and reaction to late blight showed that cultivars response significantly ($p < 0.05$) varied for the parameters studied. Area Under Disease Progress Curve (AUDPC) was lower (110) for both Tolcha and Wechecha. The cultivars Menagesha and Genet out yielded others and showed a low disease incidence of 330 and 220 AUDPC, respectively.

In the second trial, yield performance across locations showed that the recently released variety, Zengena (CIP-380479.6), followed by clones CIP-387412.2 and CIP-387315.2 gave a tuber fresh yield of 30.8, 27.5 and 22.4 t/ha, respectively.

Farmer evaluations for boiled potatoes varied across locations. Majority of the farmers preferred clone CIP-383032.15 followed by CIP-387315.2.

Introduction

Potato (*Solanum tuberosum* L.) is a very important food and cash crop in Ethiopia, especially in the high and mid-altitude area. It has a great potential to supply high-quality food within a relatively short period. It is also one of the cheapest sources of energy.

Potato has been grown in Ethiopia since its introduction by Schimper, a German botanist, in about 1858 (Punkhurst 1964). Unlike its long history of cultivation and availability of suitable climatic and edaphic conditions the national average yield is very low estimated at 8t/ha (Potato research strategy 2000). This low yield, among other factors, is due to the use of local varieties that are low yielding

highly susceptibility to late blight and the major diseases (Berga et al., 1994). The local varieties may be of the same progeny introduced by shimper (Haile-Michael, 1979) suggesting the narrow genetic availability of varieties grown by farmers. The Ethiopian potato program has been conducting on station screening of varieties for the last 25 years to develop high yielding and tolerant varieties. So far six varieties has been released (G/Medhin et al., 1998).

On-farm testing of potato varieties in west and North-West Shewa has been a conditions activity of the potato improvement preparing HARC. Selected varieties from advanced breeding trials are tested under variable farmer management conditions with the objective of encouraging farmers to participate in the evaluation and selection of varieties that would satisfy their needs and expectations; assessing the performance of advanced and released varieties under farmers cropping systems; and understanding attributes desired by farmers so as to establish feed back flow among researchers, extension workers and farmers in order to maximize selection efficiency.

Identification of Needs and Problems

A PRA survey conducted in 1997 in the highlands of West Shewa in Galessa area of the Dendi district, (Kindu *et al* 1997) showed that potato is the second most important crop next to barely. As a food crop it provides supplementary food during periods of food shortages. However, disease and lack of cultivar diversity have resulted in poor potato yields and tuber quality in the area. Similar problems have been reported in most of the potato growing areas of the country (Berga *et al.*, 1994) that has kept the national average yield as low as 8 t /ha (Potato research strategy, 2000). Farmers underlined similar problems during trainings, workshops and field days conducted by the potato program.

Agro ecology based on farm variety evaluation and selection trials have been conducted together with farmers in an a prompt to identify high yield disease resistant improved varieties that have the desired attributes by urban consumer & farmers as a potential solution to the immediate need.

Experimental Approaches

Two sets of experiments consisting of different clones and varieties were conducted from 1998 to 2000 the main rainy season, June to end of September, at different locations in different AEZ in West and Northwest Showa.

Clones: In the on-farm adaptation trial, 4 released varieties namely Tolcha, Awash, Wechecha and Menagesha), one promising variety (Genet) and a susceptible check were evaluated on 16 farmers' fields at two different locations, in 1999 and 2000. In the second experiment, 7 selected clones from the advanced breeding trials namely CIP-387315.2, CIP-382173.12, CIP-382121.5, CIP-383032.15, CIP-380479.6, CIP-384321.3, CIP-387412.2, and two checks Tolcha

and Awash were planted at 5 and 2 districts of west and northwest Showa zones, respectively.

Location: Two districts namely Galessa (2950 m.a.s.l) and Meta Robi (2530 masl) and seven districts namely Wolmera, Adaberga, Dendi, Jeldu and Tikur Inchini (West Shewa) and Girajarso and Degem (North-West Shewa) were selected for the first and the second trials, respectively.

Design: Both trials were laid out in a randomized complete block design in four replications. A plot size of 6 x 6m and 4.5 x 6m for the first and second trials were used, respectively. Agronomic practices were carried out according to the recommendations (spacing 75cmx30cm, fertilizer 110 N and 90 P₂O₅ kg/ha, twice weeding and cultivation). Planting was done at early June at the commencement of the long rainy seasons when severe late blight pressure is highly likely.

Data collection: In both trials, data were collected from center-rows of plots in all the locations. Weekly assessment of late blight severity was done using CIP scale (Hen fling, 1987). The late blight scores were used to calculate areas under disease progress curve (AUDPC) (Campbell & Madden, 1990). At harvest, tuber yield was recorded based on tuber number per plant and tuber weight. During the crop vegetative growth, field days were organized in most of the locations. Researchers, DAs and district MoA staff and farmers (participants and other growers) interacted. At harvest, a total of 76 farmers, 11 from Wolmera, 21 from Degem, 26 from Galessa and 12 farmers at Girajarso made assessments for acceptability of tuber quality, both fresh and boiled, according to the local system, and provided for taste.

Results and Discussions

Results of yield performance and reaction to late blight of the released cultivars and the local check during the main rainy season showed that cultivar responses significantly ($p < 0.05$) varied for the parameters considered (Figure 1 and 2). AUDPC was lower (110) for both Tolcha and Wechecha. However, Menagesha and Genet out yielded all others and showed a low disease incidence of 330 and 220 AUDPC, respectively. The early maturing variety Awash experienced severe late blight attack showing a decline of resistance it had during release. Probably the resistance due to the R-gene might have been broken. Varietal susceptibility as a function of maturity class has been reported in different countries (EL-Bedewy et al, 2001).

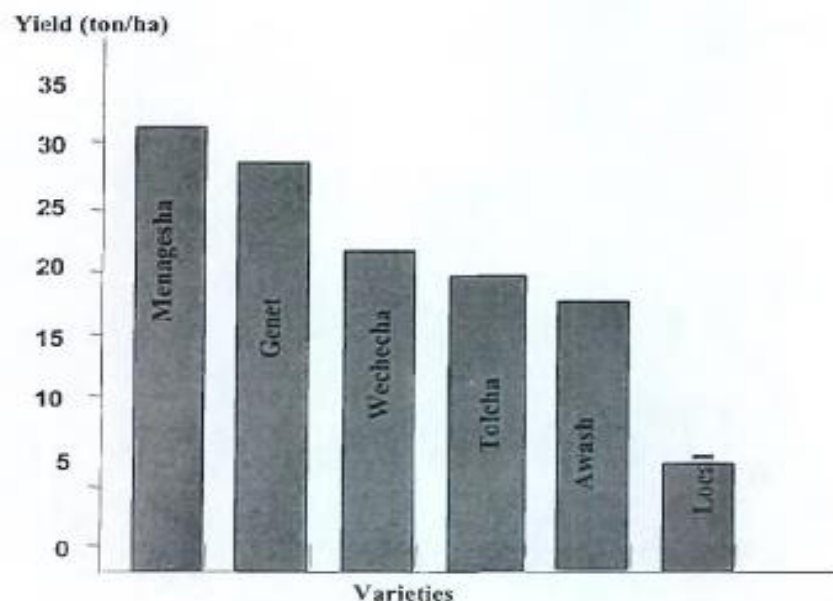


Fig. 1 Yield performance of some released potato clones during main rainy seasons (1998- 2000)

The results also indicated that in 1999, the cultivar Menagesha gave the highest average tuber weight (ATW) of 96.5gm and tuber yield of 31.3t ha⁻¹. The promising no variety Genet was the second best in the same year. The higher yield of Menagesha was due to its higher bulking character manifested by significantly higher ATW than any of the other cultivars. In the second year (2000), tuber yield of all the cultivars but Wechecha, reduced due to less bulking (reduced ATW). A combined analysis of tuber yield over the two years indicated that cultivars Menagesha, Wechecha and Genet were better alternatives among which Menagesha was the best. The non-significant statistical differences between Cultivars, however, require careful consideration as it may lead to misinterpretation. The economics of the differences can be decisive to the farmer in the choice of variety. Yield differences of 8-10 tons ha⁻¹ attributed to chances (Table 1) can partly be a problem of low precision in on-farm trials.

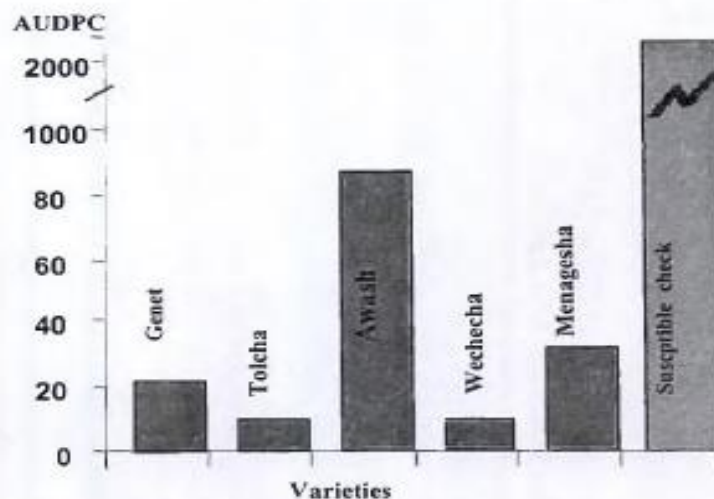


Fig. 2 Late blight severity in AUDPC of some released potato varieties during main rainy season Galessa, 2000

Significant ($P < 0.05$) differences was observed among farmers for tuber number m^{-2} and tuber yield. The main causes for the differences were variations in the soil preparation, soil fertility, weeding, and cultivation practices. This could also be an area of focus to improve the productivity of potato under farmer conditions where different recommendation domain exist within a given farming community that need a basket of options to choose from. Farmer number 4 consistently obtained the highest yields, 26.5 and 23.8 $t\ ha^{-1}$ in the two seasons. Based on the above results, an informal seed tuber production activity has been started using variety Menagesha at Galessa area.

According to farmer evaluations at Meta Robi, the variety Genet was the best followed by Menagesha. Reasons for the preference of Genet were tuber color, size and crop stand. Some preferred Menagesha for its tolerance to late blight and hail damage.

Farmers' evaluations of the potato cultivars for quality revealed that attributes such as appearance (color or shape) of the tubers, taste (sweet or sour) and texture (mealy/leathery or friable) were the most important parameter used to identify the preferred varieties. Based on these criteria, the cultivars Tolcha, Menagesha, Awash, Wechecha and Genet ranked in the order of acceptance.

Table 1: Yield performance of improved and local potato cultivars at Galessa area.

Cultivar	Year 1			Year 2			Year average (Yield t ha ⁻¹)
	ATW (g)	ATN m ⁻²	Yield t ha ⁻¹	ATW (g)	ATN m ⁻²	Yield t ha ⁻¹	
Awash	38.6	22.9	9.2	33.8	31.8	8.5	8.8
Genet	58.3	35.5	21.2	40.7	33.0	11.2	16.2
Menagesha	96.5	32.1	31.0	63.7	35.7	22.2	26.6
Tolcha	49.4	30.2	14.9	53.3	31.7	13.0	14.0
Wechecha	51.7	29.9	15.3	63.2	31.2	21.0	18.2
Local*	-	-	0.17	-	-	-	0.1
Mean	58.9	30.2	18.3	51.7	32.7	15.2	16.8
LSD _{0.05}	15.6	2.6	15.5	15.6	2.6	15.5	11.0
Farmer							
1	54.6	29.6	16.0	38.2	38.3	9.4	12.7
2	49.6	30.4	15.6	35.2	34.7	17.4	16.5
3	52.8	27.3	15.3	28.8	28.9	10.1	12.7
4	78.5	33.3	26.5	35.2	34.7	23.8	25.1
Mean	58.9	30.2	18.3	50.9	34.2	15.2	16.8
LSD _{0.05}	13.91	7.31	5.17	13.91	7.31	5.17	3.68

* The local cultivar was not included in the statistical analysis

Performance of the clones in the second trial across the seven locations revealed considerable ($P < 0.05$) variability among clones within the same or across locations for tuber yield, ATW and ATN/m² (Tables 2-4). In Wolmera, Galessa and Adaberga, clones such as CIP-387315.12, CIP-382173.12 and CIP-382121.5 gave low tuber yield. The same clones showed better performance at Degem giving a tuber yield as high as 63, 52.2 and 42.2 t/ha, respectively. The same varieties gave higher tuber yield at Jeldu (28.5, 35.8 and 31.1) and Girarjarso (29.5, 23.2 and 23.9) t/ha. Other clones such as CIP-380479.6 (Zengana), CIP-387412.2, CIP-384321.3 and CIP-383032.15 had shown consistent yield performance across most locations.

In almost all the locations most of the clones had out yielded the standard & susceptible checks. Higher mean yields of all clones and varieties were obtained at Degem (38.5 t/ha) and Jeldu (22.8 t/ha) both are extreme highland (2800 and above) areas. Mean tuber yield across locations indicated that the recently released variety Zengana (CIP-380479.6) followed by CIP-387412.2 and CIP-384321.3 gave higher tuber yields 30.8, 25.9 & 22.9 t/ha, respectively (Table 5).

Table 2. On-farm mean yield t ha⁻¹ of potato clones in the multi-location trial in 2000

Variety/Clone	Location							Mean
	Welmera	Ada-berga	Jeldu	Tikur Inchini	G.Jarso	Degem	Galessa	
387315.2	1.4	9.0	28.5	12.0	29.6	63.0	13.2	22.4
382173.12	3.6	14.5	35.9	14.9	23.2	52.2	6.1	21.4
382121.5	2.6	9.4	31.0	10.7	23.9	42.2	12.7	18.9
383032.15	18.2	24.8	26.1	16.2	11.7	41.2	18.1	22.3
380479.6	21.0	32.4	41.6	24.6	21.9	47.4	26.7	30.8
384321.3	18.6	27.7	13.6	25.6	24.4	27.5	23.4	23.0
387412.2	23.0	27.1	33.6	19.0	18.9	47.6	12.1	25.9
Awash	1.7	5.6	8.4	7.5	9.6	31.6	10.7	10.7
Tolcha	16.2	19.0	9.5	14.0	11.0	32.7	22.6	17.9
Mean	10.7	17.0	22.8	14.4	17.4	38.6	14.6	
LSD _{0.05}	5.0	9.2	9.2	5.7	9.3	1.2	6.7	
CV (%)	29.29	33.59	24.93	24.42	27.86	20.04	26.83	

Table 3. On-farm average tube weight of potato clones in the multi-location trial in 2000

Variety/Clones	Location							Mean
	Welmera	Ada-berga	Jeldu	Tikur Inchini	G.Jarso	Degem	Galessa	
387315.2	9.06	59.18	104.0	40.04	50.55	84.89	37.21	54.99
382173.12	17.02	48.03	134.6	45.76	55.65	110.50	32.90	63.49
382121.5	8.63	22.78	88.21	29.76	37.38	39.79	36.47	37.57
383032.15	55.34	23.78	102.5	47.8	51.23	87.24	49.43	59.62
380479.6	48.81	33.38	105.7	46.07	34.07	44.52	43.69	50.89
384321.3	40.76	57.74	62.35	65.14	45.79	50.78	67.57	55.73
387412.2	42.20	52.24	83.94	56.14	32.02	55.21	28.82	50.08
Awash	18.05	53.15	60.83	35.24	33.90	58.54	-	43.29
Tolcha	62.09	59.18	75.90	56.26	52.20	68.31	45.25	59.88
LSD _{0.05}	12.88	13.75	28.76	13.68	20.26	25.66	16.917	
CV (%)	26.30	20.71	21.66	19.99	27.08	20.34	29.00	

* Average tuber wieght

Table 4. Average tuber number of potato clones in the on- farm multi-location trial in North and West Shewa zone 2000.

Variety/Clones	Location							Mean
	Welmera	Ada-berga	Jeldu	Tikur Inchini	G.Jarso	Degem	Galessa	
	10.81	32.07	30.51	31.11	8.25	75.0	34.53	31.75
387315.2	17.69	58.91	26.78	32.54	15.77	47.20	16.39	30.75
382173.12	21.77	41.52	35.21	37.76	10.87	111.20	36.90	42.18
382121.5	32.71	38.01	25.74	33.06	7.96	46.03	36.97	31.5
383032.15	44.53	17.03	40.42	54.72	6.63	112.20	63.01	48.36
380479.6	44.79	59.44	20.97	40.51	13.38	55.35	35.04	38.5
384321.3	54.44	28.01	40.26	34.04	8.24	86.20	42.31	41.93
387412.2	8.42	58.70	14.53	20.26	3.58	54.04	-	26.59
Awash	26.28	41.69	12.78	24.36	11.24	46.86	50.19	30.49
Tolcha	9.934	11.04	10.86	14.05	6.197	25.86	16.92	
LSD _{0.05}	23.43	18.11	27.09	28.07	37.50	25.14	39.42	

* Average tuber number

Table 5. On-farm mean tuber yield, ATW and ATN of potato clones in the multi-location trial in 2000

Clones/ Variety	Yield (t/ha)	ATW (g)	ATN m ⁻²	AUDPC
387315.2	22.4	54.99	31.75	3864.0a
382173.12	21.4	63.49	30.75	4010a
382121.5	18.9	37.57	42.18	793.8c
383032.15	22.3	59.62	31.5	3811a
380479.6	30.8	50.89	48.36	873.8c
384321.3	22.9	55.73	38.5	1834b
387412.2	25.9	50.08	41.93	1106bc
Awash	10.7	43.29	26.59	3594a
Tolcha	17.8	59.88	30.49	616.9c

Acceptance by farmers for boiled potatoes also varied within the same location and across locations for the tested clones/varieties. At Wolmera, the variety Awash was highly preferred followed by clones CIP-383032.15 and CIP-387412.2 while CIP-382121.5 followed by CIP-384321.3 and CIP-387412.2 were highly preferred at Degem. On the other hand, Galessa farmers selected CIP-383032.15 followed by Tolcha and CIP-382173.12 as the best cultivars (Table 6). Over all acceptances for boiled potatoes by farmers over four districts showed that clone/cultivar CIP-383032.15 was the best while CIP-387315.2 was the least preferred (Table 6).

Table 6. Farmer's evaluation for boiled potato in four districts West and North-West Shewa

Varieties	Districts				Over	Rank
	Wolmera	Degem	Girar Jarso	Galessa	All	
383032.15	6.58	5.72	6.42	7.24	6.49	1
382173.12	6.00	5.32	6.83	6.38	6.13	2
380479.6	5.64	3.58	5.75	5.90	5.22	3
Tolcha	5.88	4.88	2.83	6.87	5.12	4
382121.5	4.85	6.35	4.17	4.31	4.92	6
387412.2	4.53	6.02	5.42	3.72	4.92	6
Qwash	6.80	4.24	3.50	-	4.85	8
384321.3	5.00	6.08	5.42	3.65	5.04	5
387315.2	3.78	4.05	4.58	2.58	3.75	9

1 = Least preferred 8 = Most preferred

Problems Encountered and Lessons learned

- Farmer evaluations of the tested clones and varieties for taste did not support the statistical results; the statistical analysis mainly emphasized on yield and reaction of the varieties to late blight whereas farmers emphasized on criteria such as taste.
- Involvement of farmers in variety selection appears to improve the success of technology dissemination due to build-up of confidence by farmers on the feasibility of the technologies generated.
- The feedback obtained helped researchers to target research towards demand driven or client-oriented properties. For instance farmers prefer short stand varieties, high dry matter, good taste, short stolon, white skin potatoes.
- A remarkable increase in the interest of farmers to grow potato in the main season because of high yielding and late blight resistant potato varieties with high quality tuber.

Conclusions and Recommendations

The genotype by environment interaction approach although not statistically analyzed in this study might explain why in most cases it was not possible to have a variety that fits diverse environments. Despite this observation, the reality of the current seed flow among potato growers in different agro-ecologies in Ethiopia encourages the promotion of varieties that are widely adaptable. Multiple criteria selection of varieties could lead to recommendations, which appreciate the diverse use of varieties depending on the production objectives set forth by producers. It is recommended that breeders should include the attributes preferred by farmers in the early stage of potato variety development together with other criteria currently considered important by breeders.

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