000067

Horticulture Research and Development in Ethiopia

Proceedings of the
Second National Horticultural Workshop
of Ethiopia

1-3 December 1992
Addis Abeba, Ethiopia

Edited by
Edward Herath
Lemma Dessalegne

Institute of Agricultural Research
and
Food and Agriculture Organization

Potato Improvement Research

Berga Lemaga[1], Gebremedhin W–Giorgis[1], Teriessa Jalleta[2]
Bereke-Tsehai Tuku[1] and Yaynu Hiskias[1]
[1] *Institute of Agricultural Research,*
P.O. Box 2003, Addis Abeba
[2] *Alemaya University of Agriculture*
P.O. Box 138, Dire Dawa

Abstract

To develop high-yielding and adaptable cultivars with resistance/tolerance to the major stresses, the Ethiopian potato Improvement program has evaluated a large number of genotypes in different agro-ecologies. Since 1985, 29 cultivars have been introduced from the Netherlands and evaluated under local conditions, out of which one performed outstandingly well. Several thousand genotypes with different traits have been introduced from the International Potato Centre in the form of clones, tuber families and true potato seeds. Some of these have exhibited satisfactory performances and are now at advanced stages of selection.

Variety trials with a different set of cultivars were conducted from 1987–1989 at nine locations and from 1990–1992 at eight locations representing different agro-ecologies. The results showed that the poorest cultivar yielded at least twice and the best ones yielded at least four times than the local check. All were also superior to the local cultivar in their reaction to late blight. The cultivars yielded differently at different locations and also within a location. As a result of these and other trials, three cultivars with wide adaptability have been released and another four are candidates for release in 1993.

Parental line evaluation was made in 1988 on 14 hybrids and 11 open-pollinated true potato seed progenies. Most of the progenies produced fairly uniform tubers with average off-season yields of 46 t ha^{-1} for the hybrid and 31 t ha^{-1} for the open pollinated. Tuber yields of both the progeny types in the main rainy season were very low because of a heavy late blight attack. Generally, however, more true potato seed research is essential in potato improvement work in Ethiopia.

INTRODUCTION

Potato *(Solanum tuberosum L.)* is a very important food and cash crop in Ethiopia, especially in the high- and mid-altitude areas. Its importance is increasing. As a food crop, it has a great potential to supply high-quality food within a relatively short period and is one of the cheapest sources of energy. The production of protein per unit land is the highest among the four major food crops (potato, corn, rice and wheat) in the world. Moreover, the protein from potato is of good composition with regard to the essential amino acids in human nutrition.

The average biological value of potato protein is about 70% and more than that of whole egg, exceeded only by fish, sweet potatoes and rice with about 75% each (Horton and Sawyer 1985). Potato also has substantial amounts of vitamins, minerals and trace elements. Such a crop undoubtedly is very important for countries like Ethiopia, where inadequate protein and calorie supplies are the apparent nutritional problems.

Potato has been grown in Ethiopia since its introduction by Schimper, a German botanist, in about 1858 (Pankhurst 1964). Unlike its long history of cultivation and in spite of the production conducive environments in Ethiopia its cultivation has been limited to less than 5000 ha, with Shewa, Begemider, Gojam and Harerge being the major producers (Table 1). Although Ethiopia is endowed with suitable climatic and edaphic conditions for a high yield and production of high- quality potatoes, the national average yield is estimated at 6 t ha^{-1} which is very low by any standard. This low yield, among other factors, is attributed to the poor yielding capacities and high susceptibility to late blight and to the major diseases of the indigenous potato varieties grown by farmers.

The local varieties may be of the same parentage introduced by Schimper in the late 19th century (Haile–Michael 1979). This vividly shows that the genetic base of the local varieties is narrow making any progress in improving the productivity of the crop unsatisfactory. To make such a progress possible by widening the genetic base of the potato a selection program with a large number of seedling populations was started in 1973 at the College of Agriculture in Alemaya in cooperation with the Institute of Agricultural Research (IAR) and the International Potato Centre (CIP). A more coordinated improvement work on potatoes was started in 1975 with the initiation of the Ethiopian Potato Improvement Program (EPIP). One of the objectives of this program was to develop high-yielding cultivars adaptable to the different agro-ecologies of Ethiopia and resistant/tolerant to the major diseases such as late blight, bacterial wilt and viruses. This paper presents results of the potato improvement research work with a major emphasis on those conducted since 1985.

Strategy

To develop high-yielding cultivars suitable for the different agro-ecologies of the country and resistant/tolerant to the major pests and other stresses, three approaches (strategies) were followed.

- Introduction and evaluation of commercial varieties. Commercial cultivars released in other potato-growing countries are introduced and evaluated for their yielding abilities and resistance/tolerance to the major diseases, especially to late blight. The purpose of this trial was to develop outstanding cultivars in a short time, usually in 3–4 years. In 1987, 27 cultivars of Dutch origin were evaluated at Holetta (Table 2). Table 2 shows that, with the exception of Krolisa, all the varieties were highly attacked by late blight and thus yielded much lower than the national average. The cultivar Krolisa, since its introduction in 1985, has performed well and will be proposed for release in 1993.

Introduction and evaluation of germplasm, because commercial varieties are developed under a different set of environment other than here and usually for intensive cultivation. Emphasis in developing cultivars will be made on the introduction of germplasm, which will be followed by rigorous screening and selection under local conditions. The potential source of germplasm is CIP. Introductions are made in the form of clones, tuber families and true potato seed (TPS). The first large number introduction (3096) of potato seedling populations was made in 1973 from which several promising cultivars have been developed (Haile-Michael 1979). Since 1985, 29 varieties, 552 clones, more than 5,000 genotypes in 373 tuber families, and several thousands of TPS populations have been introduced. All the materials came from CIP except the 29 cultivars that came from the Netherlands. Of this huge number of genotypes, 3 varieties have been released, 4 candidate cultivars have been selected for release in 1993, 9 are in the national variety trial (NVT), 10 are in the pre-national variety trial (PNVT), and over 200 advanced clones have been selected. This shows that the percentage of clones that reach the multilocation variety trial is very small.

Table 1. Land under potatoes production/ cultivation in Ethiopia

Region	Area under cultivation (ha)
Shewa	19789
Gonder	15830
Gojam	3955
Harerge	2453
Sidamo	957
Welega	899
Arsi	603
Kefa	372
Gamo Gofa	348
Tigrai	230
Welo	226
Bale	98
Ilubabor	82
Total	46201

Source: Horticulture Division (MOA), Preliminary survey of land (unpublished)

- Generation of local populations. Local populations with outstanding traits are generated by crossing desirable parents locally. To date, very little has been done, but the reciprocal crosses made between the released varieties AL-624 and Sissay have produced promising F_1 with regard to tuber uniformity, yield and other traits. This activity will be strengthened in the future.

Selection Criteria and Screening Procedures

Upon introduction of germplasm, as mentioned above, the material is planted at Holetta in isolation following quarantine procedures. Main emphasis in the first year is given to the multiplication and screening of materials for their horticultural characteristics. The most desirable traits are tuber shape, eye depth, and color; flesh color and sprout length. Genotypes with odd shape and color, deep eyes, and excessively long stolons are rejected. In the following one or two years, the selection will be based on major attributes like resistance/tolerance to major stresses, especially late blight, bacterial wilt, heat, low moisture and low temperature. Earliness is also given an important consideration. It is only at a later stage, starting from the PNVT, that yield is given a major consideration together with field resistance to late blight. Mainly based on these two criteria, cultivars are evaluated in different agro-ecologies under the national variety trial. The screening procedure takes nine seasons which usually means 7–8 years to release a variety.

Prenational Variety Trial

Advanced clones with outstanding performances in the first two screening seasons are replicated in the PNVT at Holetta for two years before they are promoted to the NVT. Table 3 shows the performance of cultivars included in the PNVT in 1981. All the selected cultivars produced a significantly greater number of tubers and yielded significantly higher than the local check. The poorest performing cultivar yielded over four times higher than the check and the best performing cultivar yielded eight-fold. The check, however, produced more stems than about 50% of the cultivars. Many authors, including Bleasdale (1965), Collins (1977) and Berga and Caesar (1990) have reported that stem number and yield are positively related. The lowest yield of the check and its yield are positively related. The lowest yield of the check, despite a good number of stems, in this study might have been attributed to the heavy attack of late blight that decreased both the number of tubers initiated and the subsequent tuber bulking. The check cultivar was the shortest, and though it is not well known whether or not plant height is a yield-determining parameter.

Table 2. Mean tuber yields and late blight reactions of 27 commercial potato cultivars introduced from Europe, 1989

Cultivar	Yield (t ha^{-1})
Krolisa	20.6
Vitorini	3.6
Arka	3.6
Barka	3.4
Gigant	3.3
Origo	3.2
Jaerla	3.0
Berber	2.9
Delcora	2.8
Oblix	2.7
Desiree	2.7
Nicola	2.7
Escort	2.6
Cleopatra	2.5
Mansour	2.4
Draga	2.4
Ajax	2.1
Kondor	2.1
Morene	2.1
Frisia	1.8
Romanze	1.7
Diament	1.5
Cara	1.5
Spunta	1.4
Famosa	1.2
Cardinal	1.2
Alpha	0.9
Local	0.9

National Variety Trial

Cultivars that reacted to late blight and gave higher yield in the PNVT are promoted to the NVT for further evaluation across several locations with different weather conditions (Table 4). The 1987–1989 summary shows that there was a significant yield difference between locations. The highest yield (28.3 t ha^{-1}) was recorded at Bekoji and the lowest (13.7 t ha^{-1}) at Holetta. Low yields were obtained also at Melkassa and Bako, where suboptimal weather conditions and a heavy late blight pressure, respectively, were the probable reasons. The very low yield at Holetta could be attributed to both heavy late blight attack and virus buildup. The weather data show that all the locations are suitable for potato production, with a probable exception of Melkasa. Low moisture and high temperature are the major constraints to high productivity at Melkasa unless early-maturing and heat-tolerant cultivars are developed. The varieties also differed significantly in their tuber yields, late blight infection rate, and late blight field reaction (Table 5). The cultivars K-59-A (26), CIP-37836.4, CIP-378501.3 and CIP-378329.7 outyielded the standard check Sissay. The first three were recommended for release in the 1990 cropping season. Of these, CIP-378501.3 was released and K-59-A (26) recommended for verification. The variety K-59-A (26) will be put again under a verification trial in the 1993 crop season. Yield differences between cultivars cannot be attributed only to differences in their reaction to blight, but also to their genetic potential for high yield. This should be done because some cultivars had yielded very poorly even though they had the lowest infection rate and a horizontal resistance to late blight resistance.

Table 3. Plant height, stem number, tuber number and total tuber yield of cultivars included in the prenational variety trial at Holetta in 1991

Cultivar	Plant height (cm)	Stem No per plant	Tuber No/m^{-2}	Tuber yield (t ha^{-1})
CIP -381403.40	40.3	4.0	37.6	40.9
-384321.19	50.9	4.3	70.0	34.3
-384376.3	46.6	3.1	52.9	30.9
-383032.15	49.7	4.0	50.9	30.1
-384321.16	44.1	5.4	74.9	28.2
-384321.9	53.5	7.7	87.9	36.7
-383120.14	40.7	3.6	45.8	24.3
-384321.3	52.5	2.7	46.8	25.6
-384298.56	38.4	3.6	40.6	23.3
-384327.42	39.8	3.5	36.6	27.5
Local	23.0	3.9	21.6	5.0
LSD 0.05	14.7	1.3	14.9	6.2

Table 4. Weather data and mean tuber yields of nine locations where the national variety trial was conducted from 1987 to 1989

Location	Altitude (m)	Rainfall (mm)	Growing (days)	Tuber yield ($t\ ha^{-1}$)
Adet	2240	1000	230	22.3ab**
Awasa	1700	1049	240	25.6ab
Bako	1650	1250	140	14.8b
Bekoji	2780	1000	285	28.3a
Holetta	2400	1100	240	13.7b
Jima	1750	1387	300	19.3ab
Melkasa	1550	776	180	14.2
Sheno	2800	800	240	17.6ab
Sinana	2400	900	285	25.0

* Each mean is an average of 10 cultivars and three years
** Means followed by the same letter are not statistically different at $p<0.05$

Table 5. Mean tuber yields, late blight infection rates, and late blight field reactions of 10 cultivars in the national variety for the (1987–1989)

Cultivar	Tuber yield ($t\ ha^{-1}$*)	Late blight infection rate	late blight field reaction
K-59-A 26	24.6a**	0.066	HR
CIP-378367.4	24.3a	0.109	HR
CIP-378501.3	23.7a	0.062	V+HR
CIP-378329.7	23.2a	0.055	HR
Sissay	22.0ab	0.118	HR
AL-107	20.5b	0.080	HR+V
CIP-378371.5	20.3b	0.030	HR
AL - 119	19.7b	0.038	HR+V
CIP-378329.8	16.0c	0.053	HR
Local	6.8d	0.342	Susceptible

* Each value is an average of nine locations and three years.

** Means followed by the same letter are not statistically different at $p < 0.05$, using Duncan's Multiple Range Test.

Table 6. Mean tuber yield, tuber number and average tuber weight of cultivars included in the national variety trial in 1990 and 1993 crop seasons

Cultivar	Tuber no. (m^2)*	Average tuber wt.* (g)	Tuber yield (t ha-1*)
CIP-289479.6	63.2	47.0	29.0
UK-80-3	45.2	56.7	24.4
CIP-374080.5	38.2	32.2	24.1
Krolisa	36.4	58.8	22.3
CIP-573268	42.2	56.2	20.8
Sissay (SC)	52.8	31.4	17.9
CIP-676171	38.8	47.7	17.7
CIP-513272	41.1	45.5	15.8
Local Check	26.8	20.1	5.2

* Each value is an average of five locations and two years.

Another variety trial was conducted at eight locations for another three years (1990–1993). Owing to unstable situations in 1991, and unreliable data from some locations, performance data of only 1990 and 1992 from Adet, Bako, Bekoji, Holetta and Jima have been summarized in Table 6. The local check produced the smallest number of tubers, the lowest average tuber weight, and the lowest tuber yield. The differences in terms of all the variables were significant. The cultivars that yielded well had either many tubers or large-sized tubers. Comparatively, however, tuber number seemed to be more correlated with yield than tuber size. This agrees with the results of Berga and Caesar (1990), who stated that tuber number is a stronger yield-determining parameter than average tuber weight or tuber size.

A variety trial is also being conducted at the Alemaya University of Agriculture with a different set of cultivars. Tuber yields of the 20 cultivars in the NVT (from 1987 to 1991) are presented in Table 7. These cultivars differed in their yields and there was a consistent yield reduction with time except in 1991. In the last year yields increased which might be due to improved seed quality. The reduction in yield with time was also observed at all locations where the Holetta- coordinated NVT was conducted in 1990 and 1992. This probably occurred because of the deterioration of the cultivars owing to virus infection. It is thus important to explore ways of reducing the long-time required to release a variety. On the other hand, the cultivars at Alemaya were introduced at least 13 years ago and they are still under experimentation. It would therefore be wise to recommend the best-performing cultivars for release and to replace the rest with advanced clones.

True Potato Seed Research

The conventional method of potato propagation using tubers is constrained by high costs associated with the purchase, storage and transportation of seed tubers. The use of true potato seed (TPS) as an alternative production method appears promising as it dramatically reduces storage and transportation costs. Moreover, large quantities of healthier, first-generation seed tubers can be produced from a small nursery area. These tubers can successfully be used as planting materials, as practiced in Vietnam (Malagamba and Monares 1988) and China (Li and Shen 1979). This method, however, is not without disadvantages, for each seed could potentially be genetically different resulting in non-uniform tubers. But this drawback can be overcome by careful selection of genotypes that give reasonable yields of acceptable quality tubers.

Both open-pollinated (OP) and hybrid TPS are currently in use with the latter, though expensive, performing better (Haile-Michael et al. 1985). Some research on TPS has been conducted at Alemaya and Holetta. Results from Alemaya have shown that OP/TPS cultivars AL-575, AL-624, AL-100 and AL-101 gave reasonably high yields of fairly uniform tubers. At Holetta, 14 hybrid and 11 OP/TPS progenies were evaluated in 1988. During the off-season, both progeny types performed outstandingly in terms of uniformity and yield (Tables 8). In the off-season the hybrids performed better than the OP, but the reverse was true in the main season. During the main season, both progeny types gave much lower yields than in the off-season because of a heavy late blight attack. From this and other research, it can be concluded that the possibility of using TPS for potato production in the main season does not seem feasible without the application of fungicides. In the off-season, tuber yield of the hybrid progenies ranged from 29–67 t ha^{-1} with a mean yield of 46 t ha^{-1} whereas those of the OP ranged from 25–45 t ha^{-1} with a mean of 31 t ha^{-1} (Table 8). These yields can be considered significant when compared with the national average yield of 6 t ha^{-1}. Generally, it can be concluded that launching a sound program for selecting TPS progenies with reasonably high yield of uniform tubers is an important activity in potato production in Ethiopia, especially for the off-season.

Table 7. Mean tuber yields of cultivars in the national variety trial conducted at AUA (1987–1991)

Cultivar	1987	1988	1989	1990	1991	Mean
AI-335	36.1	20.9	16.3	6.9	24.0	20.8
AI-148	31.2	20.9	16.3	3.8	23.2	19.1
AI-404	23.4	7.5	19.3	11.0	23.8	18.2
AI-578	30.2	16.5	1.8	8.7	18.6	15.1
AI-253	23.2	11.4	6.4	3.6	14.5	12.4
AI-615	19.9	15.4	21.1	6.7	16.8	16.0
AI-250	19.2	13.9	9.9	4.3	20.9	13.6
AI-212	24.4	5.7	26.9	9.7	24.1	20.2
AI-531	25.5	11.1	11.6	6.8	2.4	16.3
AI-100	21.3	17.8	10.5	9.6	17.8	15.4
AI-108	19.0	13.6	15.5	15.6	14.4	15.0
AI-624	30.9	15.6	14.7	12.2	21.2	18.9
MC-LC-2	16.6	15.2	6.4	6.5	14.8	11.9
AI-528	18.7	22.6	9.3	8.4	31.8	18.2
CIP-378329.7	17.1	18.6	16.9	12.9	15.7	16.3
CIP-377501.3	16.0	16.3	11.3	15.3	20.8	15.9
CIP-378367.4	16.8	32.1	-	3.7	38.1	22.6
AI-601	25.5	14.9	14.3	7.8	19.3	16.4
AI-305	17.5	19.7	8.1	12.1	32.2	17.9
AI-I (Mogor)	9.5	10.6	-	8.8	15.8	11.2

Table 8. Tuber yield, tuber number and tuber size distribution of hybrid progenies during the off-season of 1988

Progeny	Tuber yield (t ha^{-1})	Tuber number/m^2	Tuber size distribution (%) of total yield (>20 g)	(20-60 g)	(>60 g)
CIP-987004	67	201	18	26	56
CIP-978001	59	124	8	29	63
CIP-985001	56	184	22	31	47
CIP-980003	53	204	21	28	51
CIP-985004	53	204	24	32	44
CIP-986004	53	133	15	24	61
CIP-985002	52	131	12	26	62
HK-87-15	51	162	14	49	37
CIP-984001	39	140	29	22	49
CIP-987001	36	137	21	32	47
CIP-987002	34	140	31	31	38
CIP-981003	34	141	29	34	37
CIP-981005	33	130	22	34	43
CIP-978004	28	110	21	29	50
Mean	46	153	20	30	50
LSD 0.05	29.2	79			
Al- 601	42	199	42	22	36
Al-417	35	235	33	27	40
Al-560	34	140	32	25	43
CIP-378371.5	33	149	29	31	40
Al-459	32	96	35	24	41
Al-563	32	121	30	23	47
OK-86-235	29	162	40	19	41
UK-80-3	26	105	24	33	43
Al-107	25	116	42	22	36
OK-87-134	25	85	19	26	55
Mean	31	137	31	26	43
LSD	5.2	128			

Source: Bereke-Tsehai et al. (1991)

Conclusions

The long term potato improvement research indicated that across agro-ecologies, the good-performing cultivars yielded at least four times more than the local check; these cultivars also exhibited a much better reaction to the major disease, late blight. Tuber yields also differed significantly across locations and among cultivars within a location indicating the importance of developing varieties for specific agro-ecologies. At all locations and in all the cultivars, yield decreased with time most probably because of degeneration of cultivars owing to pathogens, especially viruses.

Parental line evaluation of both OP and hybrid TPS progenies revealed that in the off-season both the progenies gave fairly uniform tubers with a significantly higher yield than what is now recorded as the national average. In the main rainy season, however, both progenies yielded very poorly. In the off-season the hybrids performed better, while in the dry season the reverse was true.

RECOMMENDATIONS

- The current potato improvement research has to be strengthened in both workforce and facilities. The institutions involved in this research, e.g. IAR and AUA, should work in a more coordinated manner.
- In the foreseeable future CIP should continue to be the major source of germplasm with due consideration to the generation of local populations through crossing.
- Developing cultivars for the specific agro-ecologies in the country should be aimed at, along with the release of cultivars of wider adaptability.
- The time required to release a variety should be reduced (from the current about eight years to six years or less) to insure better health of the potatoes by the time they reach farmers.
- Improvement research should be assisted with biotechnology to make it more efficient ad fruitful.

Acknowledgements

We are very grateful to Ato Endale Gebre for his unreserved technical assistance and to Ato Tamiru Mihrete, W/o Tenagne Eshete and Ato Melaku Demissie for their assistance in data collection and preparation. We wholeheartedly thank the assistance of technical staff of Horticulture Division at IAR centers where variety trials were conducted. We are also thankful to W/t Fantaye Balcha for typing the manuscript. Most of the germplasm used for the improvement research was obtained from CIP, we thus gratefully acknowledge their constant support.

References

Bereke-Tsehai Tuku, Wolde-Giorgis, Berga Lemaga and Yaynu Hiskias. 1991. Evaluation of hybrid and open-pollinated true potato seed progenies during two contrasting seasons in Ethiopia. p. 23–29. *In*: L.J.C. Autrey, G.L.T. Hunt, N. Govinden and P. Ferre (eds.). 1991. Proceedings of the Second Triennial Meeting and Conference of the African Potato Association, Mauritius, 22-27 July 1990. African potato Association, Reduit, Mauritius.

Berga Lemaga and K. Caesar. 1990. Relationships between numbers of main stems and yield components of potato (*Solanum tuberosum* L. cv. Erntestolz) as influenced by different day lengths. Potato Research 33:257–267.

Bleasdale, J.J.A. 1965. Relationships between set characters and yield in main crop potatoes. J. Agric. Sci., Camb. 64:361–366.

Burton, W.G. 1989. The potato (3rd ed.). Longman Singapore Publishers Pte. Ltd. Singapore.

Collins, W. P. 1977. Analysis of growth in Kennebec with emphasis on the relationship between stem number and yield. Am. Potato J. 54:33–40.

Haile-Michael Kidane-Mariam. 1979. Preliminary assessment of the responses of potato genotypes in the eastern, southern and central regions of Ethiopia. Ethiop. J. Agric. Sci. 1(1):41–47.

Haile-Michael Kidane-Mariam, G.C. Arndt, A.C. Macaso-Khwaja and S.J. Peloquin. 1985. Comparison between 4x X 2x hybrid and OP true potato seed families. Potato Research. 28:35–42

Horton, D. and R. L. Sawyer. 1985. The potato as a world food crop, with special reference to developing areas. P.1-34. *In*:P.H. Li (ed.) Potato physiology. Academic Press, Orlando, Florida.

Li, C. H. and C. P. Shen. 1979. Production of marketable seed potatoes from botanical seed in the Peoples Republic of China. Report of the CIP planning conference on the production of potatoes from true seed. Manilla, the Philippines. p. 21–28.

Malagamba, P. and A. Monares. 1988. True potato seed: past and present used. CIP, Lima, Peru. p. 11–12.

Pankhurst, R. 1964. Notes on a history of Ethiopian agriculture. Ethiopian Observer. 7:210–240.

Discussion

Q. **Mengistu Hulluka:** In the three-years multilocational tests, the decline in yield of potato was blamed on degeneration. Why can not it be owing to variation in the environment over the three years? To minimize degeneration, why dont you advance by having two generations per year?

A. **Berga Lemaga:** When I say degeneration, I am not referring to genetic degeneration, but to generation caused by pathogens, especially viruses. As time elapses, the buildup of diseases increases and this in turn results in low yield. This, I think, holds true for all crops. Variation in environment may contribute to a decline in yield, but it is difficult to assume that the environment progressively changes to lower yields. If the weather changes to better and if the soil is supplemented with fertilizers, there is no reason why yield should not increase. The most probable reason for the decline in yield can thus will be the poor quality of seed tubers inflicted by diseases. The suggestion on minimizing degeneration is quite valid, but since our major objective is to develop varieties resistant to late blight, we preferred to use the main rainy season only, because in the off-season the probability of late blight attack is low. We can most probably reduce the years by reducing the time for the pre-national variety trial (from 2 years to 1) and the national variety trial (from 3 years to 2). Tissue culture would be the best solution.

Q. **Mesfin Ameha**: You suggested the need for a tissue culture technique for Ethiopia; can you comment on the position of the present technology with regard to mass propagation using tissue culture in the case of potato?

A. **Berga Lemaga**: Tissue culture is an excellent technique and is also very useful in the rapid multiplication of potatoes. This technique is very useful for mass propagation as well, for it enables to harvest a large number of small, healthy tubers from a small area. Small tuberlets can further be multiplied, with each yielding quite reasonably. The multiplication rate can be significantly increased if other rapid multiplication techniques such as apical cutting methods, are used. The plantlets produced from tissue culture can also be planted in the field (nursery), with a high density to harvest a large amount of seed potatoes for further multiplication. From all these, we can say that tissue culture plays a vital role in the mass propagation of potatoes.

Q. **Mengistu Hulluka**: Where are we in TPS technology in terms of commercial production?

A. **Berga Lemaga**: We have not yet used TPS for commercial production in Ethiopia. It will take some time before this can be realized locally. We, however, have adequate research information that TPS can be promoted to a commercial level, especially by producing seedling tubers in a nursery for use as planting materials in the subsequent season (for the production of ware potatoes). Experiences in China, Vietnam and other countries proved that propagation using TPS is a promising alternative means of potato production. China is known for its extensive use of TPS for propagation.

Q. **Teklu Damte**: When you conduct crop improvement research do you take into consideration the post harvest characteristics and the market demand of the crop?

A. **Berga Lemaga**: We conduct storability studies. This is important for seed potatoes. Since potatoes are dormant after harvest and since there is no surplus produce that necessitates a long-period storage (as of now), we have done much on storage of ware potatoes. This will be a research area in the future. At this time, we would like to advise consumers to store ware potatoes in the dark. We do some quality tests, especially table quality of potatoes; we also select cultivars based on their tuber shape, color, eye depth, etc. We believe that these will affect their demand by consumers. Generally, the answer to your question is yes!