Research Article **Open Access**

Abebe Chindi*, Egata Shunka, Atsede Solomon, Gebremedhin W/Giorgis, Ebrahim Seid, Lemma Tessema

Participatory potato seed production: a breakthrough for food security and income generation in the central highlands of Ethiopia

DOI 10.1515/opag-2017-0021
Received November 10, 2016; accepted March 23, 2017

Abstract: Quality seed is one of the major bottlenecks hampering the production and productivity of potato not only in Ethiopia but also in Sub-Saharan Africa. Since the 1970's, the Ethiopian Institute of Agricultural Research has generated a number of improved potato production technologies such as improved varieties with accompanying agronomic practices, crop protection measures, postharvest handling techniques and utilization options. The developed technologies were promoted from 2013-2015 via technology promotion and popularization to the Wolmera, Adea-Bera and Ejere districts with the objective of creating awareness and up scaling of improved potato production and utilization technologies. The Potato Improvement Research Program and the Research and Extension Division of Holetta Research Center in collaboration with extension staff of the Ministry of Agriculture (MoA) undertake this activity. The farmers were selected and organized in Farmer Field Schools and all stakeholders were engaged before distributing potato seeds and planting on selected farmers' fields for demonstrating of potato production technologies. A total of 899 farmers and 40 agricultural experts were trained and 27.7, 9 and 5.5 tons of quality seeds of Gudanie, Jalenie and Belete potato varieties, respectively, were delivered as a revolving seed with their recommended agronomic packages; this amount of seed covered 21.1 ha. A total of 16 farmer groups from Wolmera, 7 from Adea-Berga, and 11 from Ejere participated. They produced over 434 tons of relatively clean seed and constructed 8 diffused light stores. In addition to the demonstration of improved potato varieties, information dissemination was also an important component of the program to raise awareness for a large numbers of potato growers through farmers' field days, pamphlets, and mass media. Each year about three field days were organized and more than 1500 pamphlets were distributed to farmers invited from neighboring districts and 'Kebeles' to enhance speed. Through this intervention farmers are now harvesting a yield of about 26-34 t/ha up from 8t/ha when they were using inferior quality potato seed; this has made the farmers in the intervention area more food secure especially during the usually food scarce months of August to October when cereal crops are generally yet to mature. The farmers are also getting additional income from the sale of excess potato and are able to better meet other necessary costs like school fees, for their children.

Keywords: Potato, food security, Participatory seed production, Farmer Field School, income generation

1 Introduction

Potato (*Solanum tuberosum* L.) is the world's number one non-grain food commodity (Rykaczewska 2013) and the third most important food crop globally in terms of consumption in after rice and wheat (Birch et al. 2012; FAO 2013; Hancock et al. 2014) and over half of all production occurs in developing countries (Devaux et al. 2014), with nearly 400 million tons produced worldwide every year, leading to stability in food supply and socioeconomic impact (Halterman et al. 2016). Potato is also the fastest growing staple food crop and source of cash income for smallholder farmers in Ethiopia (Beliyu and Tederose 2014; Berhanu and Getachew 2014). It is a critical crop in terms of food security (Birch et al. 2012). It provides significant amounts of nutritional value for small-scale rural farmers

***Corresponding author: Abebe Chindi,** Ethiopian Institute of Agricultural Research/EIAR/, Holetta Agricultural Research Center, Ethiopia, E-mail: abechindii@yahoo.com
Egata Shunka, Atsede Solomon, Gebremedhin W/Giorgis, Ebrahim Seid, Lemma Tessema, Ethiopian Institute of Agricultural Research/EIAR/, Holetta Agricultural Research Center, Ethiopia

such as protein, vitamins, macro-and micronutrients, polyphenols, carotenoids and tocopherols (Brown 2005) to the human diet. In developing countries and under marginal growing conditions, potato is a cheap source of nutrients, thus playing an important role in guaranteeing food security, income generation, and employment opportunity (Lutaladio and Castaidi 2009). Potato's short cropping cycle allows it to serve as a hunger-breaking crop, and makes it suitable for intercropping and double cropping, especially in cereal-based production systems in Africa and Asia (Cromme et al. 2010) and in cropping systems.

Potato plays an increasing role in the livelihood of people in Eastern Africa as a cash and food security crop (Lung'aho et al. 2007). Potato production in Sub-Saharan Africa has more than doubled since 1994, with 70% of the growth concentrated in eastern Africa (FAO and CFC 2010). Potato is tagged as particularly important as a food security crop in Ethiopia (Hirpa et al. 2010). Like many other countries in the world, potato is a very important food and cash crop especially on the highland and midaltitude areas of Ethiopia (Borgal et al. 1980). It is regarded as a high-potential food security and stable food crop, because of its better ability to provide a high yield of high-quality product per unit input with a shorter crop cycle (mostly less than 120 days) compared to major cereal crops like maize (Hirpa et al. 2010). It is a high potential food security crop in Ethiopia due to its high yield potential and nutritional quality of the tuber, short growing period, and wider adaptability (Tewodros et al. 2014). Potato is considered one of the spearheads of agricultural policy by the Ethiopian policymakers because of its potential for food security, export, and income generation (Abebe 2013). It is also appreciated for its high yield per unit area of land and as a good source of nutritious food and cash by a large number of food-insecure smallholder farmers and pastoralists in Ethiopia (Haverkort et al. 2012).

In Ethiopia, demand for potato is increasing because of an increase in urbanization and a change in consumption patterns towards processed products like potato chips (Tesfaye et al. 2010). More than 3.3 million smallholders are engaged in potato production and over 1.61 million tones of potato was produced in 2013/14, a 71% increase compared to production in 2008/09 (CSA 2014). Analysis of its production trend during the past two and a half decades had shown an increase of 61% in area coverage and 362% in production volume (FAO 2013; CSA 2014). Total area allocated to potato also expanded by over 9% from 0.16 million hectares in 2008/09 to nearly 0.18 million in 2013/14 (CSA 2014). Similarly, average potato yield exhibited a 57% growth from 5.7 t/ha in 2008/09 to 9.0 t/ha in 2013/14 (CSA 2013). However, Hirpa (2013) stated that the area of land under potato is only 2.3% of the total area potentially suitable for potato production. According to Hirpa (2013), expanding potato production to new farmers within potato growing areas and introducing potatoes to new areas are among the strategies aimed at increasing potato production in Ethiopia. On the other hand, the yield is currently very low compared to the world's average of 17 t ha^{-1} and to other potato producing countries, such as New Zealand (50 t ha^{-1}), the Netherlands (44.7 t ha^{-1}), USA (44.6 t ha^{-1}), South Africa (34 t ha^{-1}), Egypt (24.8 t ha^{-1}), and Morocco (24.2 t ha^{-1}) (FAOSTAT 2010).

The current average potato yield in Eastern Africa has been reported to be about 8 t ha^{-1} (Geldermann et al. 2013), which is well below the maximum yield of 25 t ha^{-1} attained by some progressive smallholder farmers, harvesting in the same soils and under the same rain-fed conditions in the region. Roy (2014) reported that seed was the most important factor in ensuring the harvest of a good crop, and that use of quality seeds alone could enhance crop productivity by 15-25%. Moreover, Gildermacher et al. (2011) explained that seed accounted for 40–50% of the cost of potato production, and that improving seed potato quality and availability would be one way of improving potato productivity and profitability among communities where this crop is a mainstay. Additionally, potato seed quality is an important determinant of the final yield and quality. Low quality seed is believed to be one of the major yield reducing factors in potato production in Sub-Sahara Africa (Struik and Wiersema 1999; Fuglie 2007).

Limited supply of high quality seed tubers and high costs are major constraints to potato production in many developing countries like Ethiopia (Gildemacher et al. 2009). Many farmers use low quality seed, recycled over many generations, and leading to low yields. The common practice is use of potatoes from the previous harvest as seed potatoes, which incurs in an accumulation of seed borne diseases or degeneration of the seed potatoes, resulting in lower yields and quality (Hirpa et al. 2010; Haverkort et al. 2012). Thus, replacing the seed each season with high quality seed from specialized seed growers is preferable; it minimizes virus pressure and maximizes production potential. Nevertheless seed potato supply has not been taken up by seed companies and is overlooked in the formal seed system of Ethiopia. Due to the absence of a formal and responsible body for the production of quality seed-tuber, research centers have been using various approaches to enhance farmers' access to improved potato varieties in the past several years. Organization of farmers to groups, training them on quality seed-potato production techniques, and supply of starter pathogen

tested seed tubers are the main pillars of this strategy. Plant tissue culture laboratories at Holetta have enhanced the efficiency of this strategy by enabling pathogen-testing and subsequent mass-propagation of seed tubers. Consequently, the informal seed system still reigns in much of the country. Quality control and certification is very weak because farmers are not willing to pay high(er) prices for quality seed potatoes because they cannot be sure that they are getting a genuine product. Therefore, participatory seed production using the Farmer Field School (FFS) approach is an alternative for accessing quality seed as well as other improved technology packages for potato production and easy dissemination of information in collaboration with other stakeholders such as Ministry of Agriculture (MoA).

Against this background, popularization or up scaling of evidence-based best practices of improved technologies for potato were undertaken in a participatory approach to improve the livelihoods of smallholder potato producers in Wolmera, Adea-Berga, and Ejere districts of Western Shewa Zone, Ethiopia, during the 2013 to 2015 main cropping season.

The objectives of the work were:

- Increasing awareness of the benefits of improved seed potato quality management and crop husbandry,
- Increasing the access to potato technologies at an affordable price,
- To train farmers on the sustainable production of clean and healthy seed potatoes, post harvest management and utilization.

2 Methodology

2.1 Participatory informal seed production

Participatory potato technology development and dissemination were undertaken in the central highlands of Ethiopia. The method used to address the constraints of potato production and to disseminate the available technologies was informal seed production through a farmers' participatory approach encompassing FFS, training, and field days. These activities were aimed at increasing awareness of the benefits of improved seed potato quality management and crop husbandry. Moreover, the aim was to help farmers to access potato technologies at an affordable price and to train farmers in the sustainable production of clean and healthy seed potatoes, post-harvest management and utilization.

2.2 Organizing farmers' groups

After site selection and through discussion with the Districts' Bureau of Agriculture (BoA), the FFSs were established in villages based on group interest. The FFSs had 20–25 members and included five females headed households (this implies that 5 members are females having their own land). The activity was conducted from 2013 to 2015, and a total of 27.7, 9.0 and 5.5 tons of clean seed of Gudanie, Jalenie and Belete potato varieties, respectively, were disseminated from Holetta Agriculture Research Center (HARC) to the seed-producing groups. Training was given by staff from HARC on potato seed production and postharvest management techniques. The training was organized with practical exercises in farmers' fields. Depending on availability of planting material and number of FFS group members, about 1–2 tons of seed potato tubers were given to each of the FFS members during planting time. The initial technical intervention packages included: (i) three improved potato varieties, namely Jalenie, Gudenie and Belete, with a yield potential of 29 t/ha, 45 t/ha and 47 t/ha, respectively; (ii) recommendations for plant spacing of 75 cm between rows and 30 cm between plants; (iii) fertilizer at a rate of 195 kg/ha DAP and 165 kg/ha Urea; (iv) recommended postharvest handling techniques, such as Diffused Light Stores (DLS); and (v) other recommended practices, such as integrated disease control, land preparation and ridging. Fungicide (Ridomil MZ) was sprayed on each of the farmers' fields to control late blight disease where disease occurrences were observed. On-station and practical based training with demonstrations on potato diseases and their control measures were given to the farmers during and after planting. Field days were organized in each district to share experiences among the groups and other invited farmers around the intervention area.

2.3 Capacity building

Practical training that focused on quality seed tuber, agronomic practices, integrated disease management and postharvest handling techniques were planned and given to the FFS members, development agents (DA) and to Agricultural experts of each district. The training sessions were aimed at facilitating and assisting farmers to apply recommended agronomic practices and also construct of Diffused Light Stores (DLS).

2.4 Field days

Field sessions were conducted, covering topics ranging from site selection throughout the cropping season, field preparation to planting, fertilizer application, ridging, fungicide application to late blight disease control and management, as well as tuber post-harvest handling techniques. Field days were organized at full crop flowering in order to compare and contrast the performance of improved potato technologies with local ones and also to bring stakeholders together and discuss the status of on-going activities and linking the seed growers with ware potato producers. Moreover, participation of FFS members and non-members in the regional farmers' festivals/events was also used to promote potato innovations and create awareness among various stakeholders.

3 Results and Discussion

3.1 Participatory informal seed production

Since the start of the pre-scaling up activity in 2013 and up to 2015, a total of 27.7, 9.0 and 5.5 tons of clean seed of Gudanie, Jalenie and Belete potato varieties, respectively, were distributed. From these starter seeds, a total of 434 tons of relatively healthy seed were produced to be used as seed for the producing farmers. The seed was distributed for sale in different parts of the country for ware potato production and it enabled the seed farmers to get a good amount of income to improve their livelihoods while contributing to the availability of good quality seed. As indicated in Figure 1, it was observed that before the intervention the districts were producing less than 8 –10 t ha^{-1} of potato yields and made an income of US$1545–1932 from the sale of potato at a price of 22.7US$/100kg. However, due to best agronomic practice promotion and adoption by participant farmers, yield increases of 26 –34 t ha^{-1} were obtained which generated income values of US$5022– 6568 from sale of their produce at the same price. This suggests that there was a 70% increase in income; many reasons were given for this significant change in yield as well as income, including the much improved use of fertilizer, new seed varieties, improved cultivation practices and improved use of fungicides and insecticides. However, the main reasons cited were the training provided, followed by the improved seed varieties supplied for this activity. Therefore, the producers gained an extra yield from their potato plot which improved their income generation and livelihood. Moreover, the productivity of each district differed by potato varieties due to various reasons. Variety Belete performed better than Jalenie in all the districts, whereas it performed similarly to Gudanie at Wolmera, but better than Gudanie in Ejere district because of its high late blight tolerance in Fig. 2.The improved potato varieties produced higher yields than the local varieties used by the majority of producers. In line with this study, Gebrehiwot et al. (2013) explained that using improved potato varieties with their recommended packages has a net benefit of 112,187 Birr/ha. Whereas the use of local potato varieties and alternative crop (faba bean) resulted in a net benefit of 34,400 Birr/ha and 22,350 Birr/ha, respectively. The marginal rate of return (MRR) of shifting from the use of local varieties with farmers' practice to the use of improved potato varieties with their recommended packages is 530%. This implies that for every unit of investment in the use of improved potato varieties with their recommended packages, about 5.30 Birr extra return

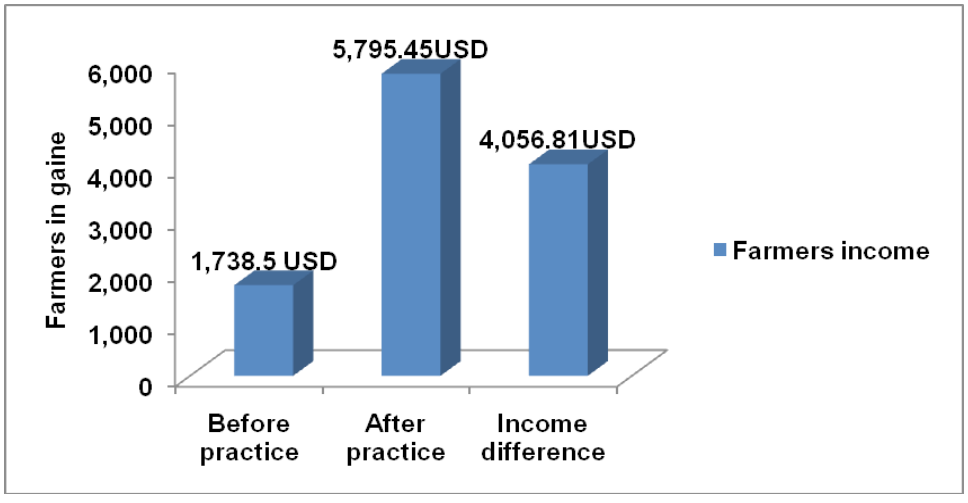

Figure 1: Average income gain of farmers' before and after the intervention

was produced, and adoption of improved varieties has further significantly improved household food security and income. In addition, farmer-based improved seed production was also found to be economically viable. For instance, in Uganda, mean returns of 216% and 82% were obtained in 1998 and 1999, respectively, while in Kenya the use of Asante and Tigoni potato varieties increased farmers' returns by 22 – 53%. In Ethiopia, ownership of livestock and other animals has increased and overall living standards greatly improved from the incomes of improved potato sales (Agajie et al. 2002).

Consequently, the pre-scaling up activity has contributed to solving the problem of seed in the country in general and in implementation districts in particular (Fig.1).

In Ethiopia, farmer-based seed production (FBSP) has been used for potato seed production (Gebremedhin et al. 2013). In this approach, farmers are provided with relatively clean starter planting materials of improved varieties from the research center, and multiply the seed to sell at an affordable price following recommended agronomic practices. Ali et al. (2014) also reported that in the central highlands of Ethiopia, one of the approaches that have the potential to empower smallholder potato producers and enhance farmer participation has been participatory research through improved seed potato production. They stated that seed potato production is a market-oriented agricultural enterprise in which farmers use improved agronomic techniques for potato production. Seed potato production is an attractive option to improve productivity of farmers as it saves their 'unproductive' labour used for subsistence cereal production (Ali et al. 2014). Farmers in the area used to experience food shortages in the months of August to October prior to their grain harvest, and households headed by females were highly vulnerable to food insecurity and other threats to livelihood in the intervention areas (Ayele et al. 2008). Thus, potato is widely considered a smallholder cash crop of the future and a pathway out of poverty. If farmers can get disease tolerant potato varieties, they will be able to produce potato in the long rainy season. It means that relatively poorer farmers can have a potato harvest prior to the grain harvest to overcome food shortages in the months of August to October, and at the same time generate cash from the sale of potatoes.

3.2 Capacity building

As a component of technology promotion, training was provided for FFS group members in three districts on potato production, disease and insect pest protection and postharvest management techniques before the distribution of planting material. During the intervention, we managed to organize and train 36 FFS groups, of which 16 were from Wolmera, 9 from Adea-Berga and 11 from Ejere, including 889 farmers and 40 agricultural experts, respectively (Table 1). Improved disease tolerant potato varieties with their recommended agronomic packages were delivered to a newly established group of FFS members using a revolving seed system, where the seed was used only for three consecutive years. Thus, the farmers produced 434 tons of healthy seed, mainly from the varieties Gudenie, Jalenie and Belete. During the activities, farmers received consecutive training sessions on integrated disease and pest management, as well as post harvest handling of their potato seed via the construction of DLS. Consequently, eight DLS were

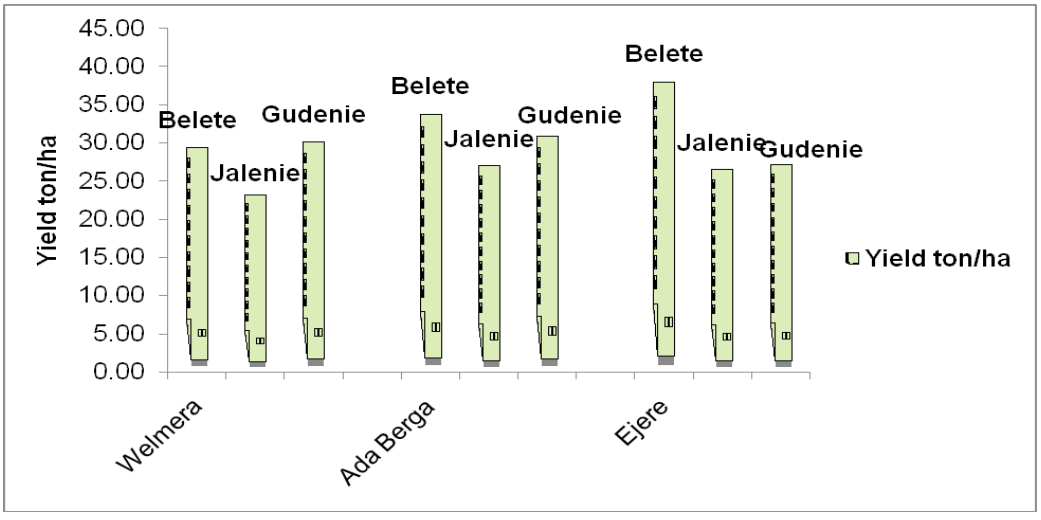

Figure 2: Performance of three released potato varieties in different districts

Table 1: Number of farmers trained on seed production, 2013–2015

Districts	Number of farmers trained					
	2013		2014		2015	
	Male	Female	Male	Female	Male	Female
Wolmera	84	111	120	45	95	25
Adea-Berga	50	15	45	12	35	13
Ejere	100	50	25	9	50	15
Total	234	176	190	66	180	53
	Grand Total 899					

constructed by seed grower FFS groups encouraged farmers to save their seed for more than eight months. The stored seeds were eventually used for the next planting and for sale, especially for ware production. Market linkages for seed tubers and ware tubers were created, which enabled sustainable seed production for FFS group members. Female farmers were trained in how to prepare different foods from potato by a technician from HARC.

Another success of the group farmers in all the districts was that the FFS members were able to organize field days on their own initiatives, paid for by districts' Bureau of Agriculture (BoA). Each year, about three field days were organized and more than 1500 pamphlets were distributed to a large number of farmers invited from neighboring districts and Kebeles to enhance the adoption of the technologies. This has helped farmers link to markets, as the field days/open days are visited by several farmers and representatives of governmental and non-governmental organizations. The regional and national media also broadcast the field days in different local languages, which helped to reach a larger audience.

3.3 Food security and household incomes improvement

Currently, several smallholder farmers are growing potatoes during the main cropping season in the intervention districts. This was not the case before the intervention due to high late blight pressure and susceptibility of local potato varieties used by farmers which were also low yielding. During September–November, farmers face food shortages and travel to far-away areas to work as day laborers. But through the intervention, LB-resistant varieties were introduced, and farmers can now produce food during the hunger period, thus making them food-secure during that time. The FFS group members testified that, "We have been able to increase our food stock in the month of October because of potato". Gebremedhin et al. (2013) stated that a modest increase in cash income through improved potato farming can have a major impact on the quality of life of the whole household and the entire community in relation to health care, nutrition, and education. In addition to food security, several farmers have increased their income from the sale of seed and ware potatoes, which has helped to improve living standards in the three districts. As income of farmers increases, their ability to deposit money in their saving accounts increases. Since the intervention, potato production has improved household food security, nutritional quality, income diversification, and overall quality of living of the farmers who participated directly and indirectly through different types of communication.

4 Conclusion and Recommendations

In the intervention districts, potato has become one of the main outfield crops. Farmers who used to produce less than 8 t ha^{-1} from local potato are currently able to produce an average of 26–34 t ha^{-1} in the main production season using quality seeds. In line with this study, Ali et al. (2014) reported that in the main production season, average potato productivity on research based and farmers' level is 29–45 t ha^{-1} and 22–35 t ha^{-1}, respectively. This is an indication that during main cropping season means high rain fall and late blight pressure. However, the improved varieties produced the above mentioned yield both under research and on farmers' field. Thus, improved potato varieties are widely recognized as fundamental to ensuring increased production and productivity (Geldermann et al. 2013). The dissemination and adoption of improved technologies and good quality starter planting material increased seed potato production and productivity and created awareness that the use of quality seed has advantages. The potato growers of Wolmera, Adea-Berga and Ejere districts were convinced that they could produce a high-quality seed and thereby improve their livelihoods. The organization of potato seed tuber growers into a FFS

group has helped them facilitate the collection and selling of their produce and improve their bargaining power. As there is no organization to multiply root-and-tuber planting materials, the intervention of research centers is essential to strengthening the existing informal seed system, and thus enables small-scale farmers to easily access potato seed at local levels.

The BoA, cooperative offices, and NGOs are expected to exert a more concerted effort in organizing farmers at a local level for potato seed production and marketing. The demand for quality seed increased exponentially due to successive training and yield increments. Moreover, during the intervention, the participant farmers gained skills and knowledge on the principles of quality seed production and& crop husbandry, to get a better yield compared to traditional practices. The FFS group members understood the use of fungicides as soon as the symptoms of late blight disease appeared, and the use of postharvest handling technologies to store seed potato tubers (DLS) for 8 – 9 months were appreciated and widely adopted. The farmers witnessed that the quality of their living standard in terms of housing, their ability to send their children to school (have managed to pay school fees without problems), buying clothing, etc. improved due to their involvement in seed production activities. Therefore, participatory seed production using FFS approach is an efficient means of getting access to quality seed as well as other improved technological packages for potato production, and information can easily be disseminated in collaboration with other stakeholders such as the Ministry of Agriculture (MoA). In general it was learned that:

- With proper technical advice and backstopping, farmers are able to produce high-quality seed through their own management,
- Farmers are willing to invest in clean/seed, as exhibited by the high number of trained seed multipliers who are currently producing seed commercially,
- Use of quality seed leads to increased tuber yields at the farm level,
- Farmers are willing to invest in the construction of DLS as indicated by the number of DLSs constructed without support,
- Use of different media such as pamphlets/leaflets, National radio & TV helps to create awareness on the use of improved varieties and healthy seed (as seen from the number of farmers demanding the technologies),
- Working in partnership is important for technology dissemination. Organizing farmers into FFSs or cooperatives helps to reach more farmers for the dissemination of technology within a short period of time, compared to dealing with individuals.

Acknowledgements: We would like to thank the Ethiopian Institute of Agricultural Research (EIAR) for financing this research and Holetta Agricultural Research Centre (HARC) to facilities and operate the research. It's our pleasure to thank International Potato Centre (CIP) for provision of potato germplasm. Last but not list we extend our appreciation to participant farmers' for their willingness, land and labor. All administration of the participant districts, Agricultural experts and development agents (DAs), research technicians involved in the activity are acknowledged.

References

Abebe G.K., Coordination mechanisms for quality improvement and market access in Ethiopian potato value chains. PhD thesis, Wageningen University, Wageningen, NL, 2013, p.220

Adane H., Economic and agronomic analysis of the seed potato supply chain in Ethiopia, PhD thesis, Wageningen University, Wageningen, NL. With references, with summaries in English and Dutch. ISBN: 978-94-6173-543-0, 2013, p.182

Adane H., Meuwissen M.P.M., Agajie Tesfaye A., Lommen W.J.M., Lansink A.O., Tsegaye A., Struik P.C., Analysis of seed potato systems in Ethiopia. Amer. J. Potato Res., 2010, 87, 537-552

Agajie T., Chilot Y., Gebre M.W.G., Mesfin H., Endale G., Potato production, marketing and utilization systems in Ethiopia: the case of East and West Shewa zones, 2002

Ali M., Wudineh G., Chilot Y., Empowering Smallholder Women Farmers through Participatory Seed Potato Management: Lessons from Welmera District, Ethiopia. Journal of Sustainable Development, 2014, 7(5), 93-110

Ayele S., Kuma B., Nesha K., Opportunities and challenges in accessing potato technologies among rural women. In Y. Chiche, & K. Kelemu (Eds.), Gender differentials for planning agricultural research: Proceedings of the workshop on gender analysis in agricultural research held 27-29 November 2006, Addis Ababa, Ethiopia: Ethiopian Institute of Agricultural Research, 2008, 89-98

Beliyu L., Tederose T., Knowledge gap in potato technologies adoption: The case of Central Highlands of Ethiopia. Journal of Agricultural Extension and Rural Development, 2014, 6(8), 259-266

Berhanu K., Beliyu L., Women Farmers in practices: Opportunities and challenges in accessing potato production technologies in Welmera Ethiopia. Asian Journal of Agricultural Extension, Economics and Sociology, 2015, 6(3), 149-157

Birch P.R.J., Bryan G., Fenton B., Gilroy E., Hein I., Jones J.T., Prashar A., Taylor M.A., Torrance L., Toth I.K., Crops that feed the world. Potato: are the trends of increased global production sustainable? Food Security, 2012, 4, 477-508

Borgal H.B., Arend C., Jacobi K., Kulazia S., Lemaga A., Mogaeka B.L., Prante W., Production, marketing and consumption of potato in the Ethiopia highlands' (Holleta, Awassa, and Alemaya), Center of Advanced training in agricultural development technology, University of Berlin, 1980

Brown C.R., Antioxidants in potato. Amer. J. Potato Res., 2005, 82, 163-172

Central Statistical Agency (CSA), Ethiopian Agricultural Sample Survey Report of 2013/2014. Statistical Report on Farm Management Practices Private Peasant holdings, Meher season, Addis Abeba, Ethiopia, 2014, Volume III, 17-19

Central Statistical Agency (CSA), Agricultural sample survey of area and production of crops of 2012/2013 (2005 E.C.) in Ethiopia. September to December 2012. Volume III. Report on area production. Private peasant holdings-Meher season. Addis Ababa, Ethiopia, 2013, p.251

Cromme N., Prakash A.B., Lutaladio N., Ezeta F., Strengthening Potato Value Chains. Technical and Policy Options for Developing Countries. Rome, Italy: Food and Agriculture Organization of the United Nations and the Common Fund for Commodities, 2010

Devaux A., Kromann P., Ortiz O., Potatoes for sustainable global food security. Potato Research, 2014, 57, 185–99

FAO, Food and Agriculture Organization of the United Nations, FAOSTAT database, 2013, http://faostat.fao.org/site/567/default.aspx#ancor, accessed 6 June 2015

FAOSTAT, Country Profile on potato production and utilization: Ethiopia, 2013

FAO and CFC, Strengthening potato value chains: Technical and policy options for developing countries. Rome, 2010, p.148

FAOSTAT, Food and Agriculture Organization of the United Nations. Agricultural data. Provisional 2009 production and production indices data. Crop primary. Rome, Italy, 2010

Fuglie K.O., Priorities for potato research in developing countries: results of a survey. American Journal of Potato Research, 2007, 84(5), 353–365

Geldermann S.E., Wachira G., Ochieng B., Barker I., Effect of Field Multiplication Generation on Seed Potato Quality in Kenya. Proceedings of the National Workshop Seed Potato Tuber Production and Dissemination: Experiences, Challenges and Prospects. Gebremedhin Woldegiorgis, Steffen Schultz and Baye Berihun (eds.). 12-14 March 2012, Bahir Dar, Ethiopia, 2013, 91-100

Gildermacher P.R., Schulte-Geldermann E., Borus D., Demo P., Kinyae P., Mundia P., Struik P.C., Seed potato quality improvement through positive selection by smallholder farmers in Kenya. Potato Research, 2011, 54, 253–266

Gildemacher P.R., Demo P., Baker I., Kaguongo W., Woldegiorgis G., Wagorie W., Wakahiu M., Struik P., Leeuwis C., A description of Seed Potato System in Kenya, Uganda and Ethiopia. American Journal of Potato Research, 2009, 86, 373-382

Hailemariam G., Woldegiorgis G., Abraha E., Lemaga B., Schulz S., Participatory Potato Seed Production in Tigray. Proceedings of the National Workshop on Seed Potato Tuber Production and Dissemination: Experiences, Challenges and Prospects. Gebremedhin Woldegiorgis, Steffen Schultz and Baye Berihun (eds.). 12-14 March 2012, Bahir Dar, Ethiopia, 2013, 91-100

Hancock R.D., Morris W.L., Ducreux L.J.M., Morris J.A., Usman M., Verrall S.R., Fuller J., Simpson C.G., Zhang R., Hedley P.E., Taylor M.A., Physiological, biochemical and molecular responses of the potato (Solanum tuberosum L.) plant to moderately elevated temperature. Plant Cell Environ, 2014, 37, 439-450

Haverkort A., van Koesveld F., Schepers H., Wijnads J., Wustman R., Zhang X., Potato Prospects for Ethiopia: on the road to value addition. Praktijkonderzoek Plant and Omgeving (Applied Research). The Netherlands, PPO Publication no. 528, 2012, p.66

Halterman D., Guenthner J., Collinge S. Butler N., Douches D., Biotech Potatoes in the 21st Century: 20 Years Since the First Biotech Potato. Am. J. Potato Res., 2016, 93, 1–20, DOI 10.1007/s12230-015-9485-1

Lung'aho C., Lemaga B., Nyongesa M., Gildermacher P., Kinyale P., Demo P., Kabira J., Commercial seed potato production in eastern and central Africa. Kenya Agricultural Research Institute, 2007, p.140

Lutaladio N., Castaidi L., Potato: The hidden treasure. J. Food Comp. Anal., 2009, 22(6), 491-493

Roy B., Farmers' participatory quality seed production of field crops - A case study. Journal of Crop and Weed, 2014, 10(2), 89-93

Rykaczewska K., The impact of high temperature during growing season on potato cultivars with different response to environmental stresses. Amer. J. Plant Sci., 2013, 4, 2386-2393

Struik P.C., Wiersema S.G., Seed potato technology. Wageningen University Press, 1999

Tesfaye A., Lemaga B., Mwakasendo J.A., Nzohabonayoz Z., Mutware J., Wanda K.Y., Kinyae P.M., Ortiz O., Crissman C., Thiele G., Markets for fresh and frozen potato chips in the ASARECA region and the potential for regional trade: Ethiopia, Tanzania, Rwanda, Kenya, Burundi and Uganda. International Potato Center (CIP), Lima, Peru. Working Paper, 2010, 1, p.44

Tewodros A., Paul C.S., Adane H., 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 , 2014, 9(15), 1218-1226

van Niekerk L., van Niekerk D., Participatory Action Research: Addressing Social Vulnerability of Rural Women through Income-generating Activities. Journal of Disaster Risk Studies, 2009, 2(2), 127-146, http://dx.doi.org/10.4102/jamba.v2i2.20

Woldegiorgis G., Negash K., Solomon A., Chindi A., Lemaga B., Participatory Potato Seed Production: Experiences from West and Southwest Shewa, and Gurage Zones. Proceedings the National Workshop on Seed Potato Tuber Production and Dissemination: Experiences, Challenges and Prospects. Gebremedhin Woldegiorgis, Steffen Schultz and Baye Berihun (eds.). 12-14 March 2012, Bahir Dar, Ethiopia, 2013, 152-172