

# Tackling Food Security and Income Generation through Participatory Potato Seed Production in Central Highlands of Ethiopia

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## Abstract

Quality seed is one of the basic problems affecting the production and productivity of potato in Ethiopia and as whole in SSA. Utilization of healthy planting material is a key factor to improve potato yields and to reduce the dissemination of pests and diseases. Decentralized, community-based seed production schemes have been established in central highlands of Ethiopia. Lack of high yielding varieties with its recommended agronomic practices also contribute significant role in food security of one country. Postharvest handling and transportation also can put considerable influence on potato production and utilizations. Therefore, technology promotions were carried out from 2013 - 2015 in three districts (Welmera, Adea-Bera and Ejere) of West shewa of Ethiopia with the objectives of creating awareness and scale-up of improved potato production and utilization technologies. This work was done by the Potato Improvement Research Program, and Research and Extension Division of Holetta Research Center (HRC) in collaboration with extension staffs of each district. Farmers' selection was made ahead of land selection, provide training, seed distribution and planting was carried out for demonstrating potato production technologies. In three years, a total of 899 farmers and 40 agricultural experts were trained and 27.7, 9 and 5.5 tonnes of quality seeds of Gudanie, Jalenie and Belete potato varieties, respectively were supplied and cover 21.1 hectares with their recommended agronomic packages. The farmers were grouped in to 16 in Wolmera, 7 Adea-Berga and 11 Ejere FFS groups. Farmer groups produced more than 434 tons of quality seed relatively from improved varieties released from research center and constructed 8 diffused light stores (DLS) to store tuber seeds they own per year. In addition, information dissemination was also made as an important component of the program to raise awareness for 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 for large number of farmers invited from neighboring districts and Kebeles that would help fast adoption of the technologies. With the use of the improved varieties and appropriate seed production techniques, members of the seed producer cooperatives obtained yields of 26 - 34 t ha<sup>-1</sup> while the national average yield is only 8 t ha<sup>-1</sup>. Therefore, the farmers in the intervention area witnessed that they are food secured during the hunger months of August to October when other cereal crops were mostly immature for consumption and also got additional income from potato production to send their children to school. It is one of the breakthroughs to avail improved technologies for the community and also improve their food security through potato technology disseminations.

**Keywords:** Potato, food security, Participatory seed production, FFS, income generation

## Introduction

Potato (*Solanum tuberosum* L.) is the fourth most important food crop and the primary non-grain food commodity in the world and the third most important food crop in terms of consumption in the world after rice and wheat (Birch et al., 2012; Hancock et al., 2014). It has been cultivated in Ethiopia for over 150 years; currently it is grown in many parts of the country (Waga et al., 2016). In Ethiopia, its production area has reached 179,159 ha cultivated by over three million households in the main cropping season of 2014 (CSA, 2014). There is a high potential to expand the cultivation area of the potato crop, as most arable land is in principle suitable for cropping with potato. Potato has multiple benefits for low income households and where land shortage is a constraint. The potato grows quickly, has a high yield, and contains more energy and protein per unit area when compared to a cereal crop. Therefore, it plays a vital role in ensuring food and nutrition security, which is a major concern for the country. However, its national average productivity was about 10 tha<sup>-1</sup> in the 2014 main cropping season (CSA, 2014), which was far below the productivity (40 tha<sup>-1</sup>) of improved varieties achieved in research trials (APHRD, 2009). 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 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 Castaldi, 2009).

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 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 mid altitude 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 has a high potential food security crop in Ethiopia due to its high yield potential and nutritional quality 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 increase in urbanization and change in consumption patterns of the urban population towards processed products like 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 decade 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<sup>-1</sup> in 2008/09 to 10 t ha<sup>-1</sup> 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. The author further indicated that, expanding potato production to new farmers within potato growing areas, and introducing potatoes to new areas are among the strategies to increase potato production areas in Ethiopia. On the other hand, the yield is very lower compared to the world's average of 17 t ha<sup>-1</sup> and to other potato producing countries of the world, such as New Zealand (50 t ha<sup>-1</sup>), Netherlands (44.7 t ha<sup>-1</sup>), USA (44.6 t ha<sup>-1</sup>), South Africa (34 t ha<sup>-1</sup>), Egypt (24.8 t ha<sup>-1</sup>), and Morocco (24.2 t ha<sup>-1</sup>) (FAOSTAT, 2010).

The current average potato yield in Eastern Africa has been reported to be about 8 t ha<sup>-1</sup> (Geldermann et al., 2013), which is well below the yields of 25 t ha<sup>-1</sup> attained by some progressive smallholder farmers, harvesting in the same soils and under the same rain fed conditions in these countries. Roy (2014) reported that, Seed is the most important input to harvest a good crop and the use of quality seeds alone can enhance the crop productivity by 15-25%. Moreover, Geldermacher et al. (2011) explained that, seed accounts for 40–50% of the cost of potato production and 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 (Struik and Wiersema, 1999; Fuglie, 2007) also indicated that, low quality seed is believed to be one of the major yield reducing factors in potato production in Sub Sahara Africa. 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).

One of the major factors attributed to the low productivity of potato is access to improved varieties. The main constraints to accessing improved varieties are lack of availability of healthy seed tubers and poor seed tuber quality (Hirpa et al. 2010; Gebremedhin et al. 2008). Adoption of improved varieties is hindered by awareness of the availability and use of improved technologies (Hirpa et al. 2010), shortage of land (CSA 2011a) and the high prices of healthy seed tubers (Agajie et al. 2013). Thus, the majority of potato growers in the country use local cultivars and poor quality seed tubers. Many farmers, therefore, use low quality seed recycled over many generations leading to low yields (Hirpa et al., 2010). The yield and quality of potato production depend on the quality of seed potatoes (Haverkort et al., 2012). The authors described that, the common practice is to use potatoes from previous harvest as seed potatoes which incurs an accumulation of seed borne diseases or degeneration of the seed potatoes, resulting in lower yields and quality. According to Haverkort et al. (2012), replacing the seed by high quality seed from specialized seed growers is preferable each season that minimizes virus pressure and maximizes production potential. Nevertheless seed potato supply has, as yet, not been taken up by the seed companies and has thus overlooked in the formal seed system in Ethiopia. Consequently, the informal seed system still reigns in much of the country. As quality control and certification is very weak, farmers are not very interested in paying high(er) prices for seed potatoes because they cannot be sure that they are getting the genuine product. Therefore, participatory seed production using FFS approach is crucial to get access of quality seed as well as other improved technology packages for potato production and easily disseminate information in collaboration with other stakeholders such as Ministry of Agriculture (MoA) and extension staff.

Therefore, the main purpose of this activity was, to popularization or scaling up of evidence based best practices of improved technologies for potato were under taken in participatory approach to improve the livelihoods of smallholder potato producers in the three districts through participatory approach for seed and

ware potato production and postharvest managements in Wolmera, Adea-Berga and Ejere districts of Western Shewa, Ethiopia during 2013-2015 main cropping season.

### **Objectives**

- Increasing awareness and income of smallholder potato farmers' by boosting potato yields through improved seed potato and crop husbandry;
- Increasing the access to potato technologies and availability of high-quality seed at an affordable price for small holder;
- To train farmers on the production of clean and healthy seed potato and its post harvest management's techniques.

### **Methodology**

#### **Participatory informal seed production**

In the central highlands of Ethiopia, participatory potato technology development and dissemination were undertaken for more than a decade. However, the adoption and uptake of those technologies were very slow due to shortage of quality seed potato tubers. The methodologies used to address the constraints of potato production and disseminate the available technologies were informal seed production through farmers' participatory approach which encompasses, Farmers Field School (FFS), trainings, field day events and use of mass media. Therefore, the intervention was undertaken in the three districts of Oromia regional state in central highlands in Wolmera, Adea-Berga and Ejere districts of Western Shewa, Ethiopia during 2013 - 2015 main cropping seasons.

#### **Organizing farmers' groups**

After site selection and through discussion with the districts BoA, the next step was to establish Farmers Field School (FFS) in the village based on the interest of the group. One FFS with 20 – 25 members were established including five female headed household. Training was given by staff from Holetta Agricultural Research Center/HARC/ on quality potato seed tuber production, various disease & insect pest management practices and postharvest handling. The training was organized with practical exercise on farmers' fields. Based on the available planting materials and number of FFS group members, about 1– 2 tons seed potato tubers were given for 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 45, 29 and 47 t ha<sup>-1</sup>, respectively; (ii) recommended agronomic packages of plant spacing of 75 cm between rows and 30 cm between plants; (iii) fertilizer 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 packages, such as disease control, land preparation and ridging. For Potato late blight control, Ridomil MZ, fungicide was sprayed on each of the farmers' fields to control late blight disease where disease occurrences observed following symptom. On-station and practical based trainings with demonstrations on potato diseases and their control measures were given to participant farmers during and after planting following the crop calendar. A field day was organized to share experiences among the group and also other invited farmers around the intervention area.

#### **Capacity building**

Practical training that focusing on technical development such as about quality seed tubers, agronomic practices, integrated disease management and postharvest handling techniques were planned to be given to the FFS group members, development agents (DA) and Agricultural experts of each districts a head of planting. Moreover, it was planned to facilitate and assist farmers to apply the recommended agronomic practices and in the construction of diffused light stores (DLS) as part of capacity building.

#### **Field days**

Organization of field days was planned to be used as an important means of bringing stakeholders together to discuss the status of on-going activities and linking the seed growers with ware potato producers. Moreover, participation of FFS member and non-participant in the regional farmers' festivals/events was also used to promote the potato innovations and create awareness among stakeholders.

### **Results and Discussion**

#### **Participatory informal seed production**

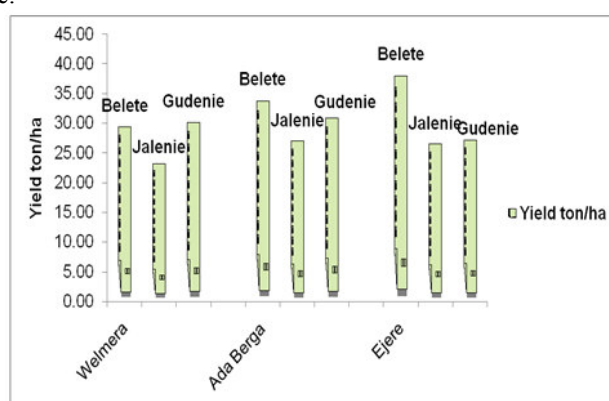
The activity was conducted from 2013 up to 2015 and a total of 27.7, 9.0 and 5.5 tons of clean seed of Gudenie, Jalenie and Belete potato varieties disseminated, respectively (Table 1). A total of 42.2 tonnes of quality seed tuber given to cover a land area of 21.1 hectares of land. From these starter seeds, 434 tons of relatively healthy seed of Gudenie, Jalenie and Belete were produced. The seed was used by FFS members for next planting and also for sale mostly within those districts which helped other farmers to access quality seed at their vicinity for

were potato production and allows farmers to get a good amount of income to improve their livelihoods while contributing to the availability good quality seed. The productivity of each district was different with regards to various potato varieties. Using three released popular varieties (Belete, Gudenie and Jalenie) an average of 34.57, 31.50 and 27.53 t ha<sup>-1</sup> at Ada Berga; 38.81, 27.80 and 27.09 t ha<sup>-1</sup> at Ejere and 30.09, 33.88 and 23.70 t ha<sup>-1</sup> at Wolmera were produced, respectively. The three years average of the varieties indicated that 34.49 t ha<sup>-1</sup> for Belete, 31.06 t ha<sup>-1</sup> for Gudenie and 26.11 t ha<sup>-1</sup> for Jalenie potato varieties, respectively.

**Table 1: Seed distributed and land area covered from 2013-2015**

Districts	Seed distributed (ton)			Area Planted (ha)		
	2013	2014	2015	2013	2014	2015
Wolmera	9.02	5.2	5.0	4.51	2.6	2.5
Ada-Berga	4.0	4.46	5.0	2.23	2.0	2.5
Ejere	3.0	4.02	2.5	1.5	2.01	1.25
Total	16.02	13.68	12.5	8.24	6.61	6.25
G.total	42.2			21.1		

It was observed that, variety Belete performed better than Gudenie and Jalenie in Ada-Berga and Ejere districts because it was a newly released variety while Gudenie performed better in Welmera district (Figure 1). Moreover, the improved potato varieties gave the highest yield as compared to local varieties used by major producers which is below 10 t ha<sup>-1</sup>. Consequently, the activity has contributed to solving the problem of seed shortage in the country in general and in those districts in particular. Thus, 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 used only for three consecutive years to reduce chance of disease dissemination. As a result, the farmer's produced 434 tons of healthy seed, mainly from the varieties Gudenie, Jalenie and Belete.



*Figure 1: Performance of released potato varieties to different districts growing location*

**Table 2: Marketable and unmarketable tuber number and yield, Total tuber number and yield, and average tuber number and yield (2013-2015).**

Districts	Variety	Marketable		Unmarketable		Total Tuber Number /m <sup>2</sup>	Average Tuber Number /m <sup>2</sup>	Average Tuber Yield (t/ha)
		Tuber Number /m <sup>2</sup>	Tuber Yield (t/ha)	Tuber Number /m <sup>2</sup>	Tuber Yield (t/ha)			
Wolmera	Jalenie	28	23.4	11	2.8	39	11	26.20
	Gudenie	30	29.7	15	3.0	45	14	32.70
	Belete	29	37.3	12	5.8	41	15	43.10
Ejere	Jalenie	27	19.5	15	3.8	42	10	23.30
	Gudenie	36	34.1	19	5.5	55	12	39.60
	Belete	36	48.8	13	6.0	49	11	54.80
Ada- Berga	Jalenie	29	26.1	24	5.9	53	12	32.00
	Gudenie	37	30.3	19	6.7	56	13	37.00
	Belete	36	42.5	17	5.7	53	12	48.20
Average	Average	32	32.4	16	5.0	48	12	37.40
	Jalenie	28	25.1	17	4.1	45	11	29.20
	Gudenie	34	29.3	18	5.0	52	13	34.30
	Belete	34	42.9	14	5.8	48	13	48.70

As indicated in (Table 2) the three varieties gave reasonable marketable tuber number as well as tuber yield in the three districts. Moreover, the average tuber yield of Belete was very remarkable as compared to



others but the remaining two varieties were also very well adopted by producers due to their long lasting during the storage and have good taste especially for boiled potatoes. In Ethiopia, farmer based seed production (FBSP) has been practiced for potato seed production (Gebremedhin et al., 2013). In this approach, farmers are provided with relatively clean starter planting materials of the improved varieties from the research center and multiply following recommended agronomic practices for potatoes and the seed to be sold at an affordable price. 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 enterprises 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 shortage in the months of August to October prior to their grain harvest, and female headed households were highly vulnerable to food insecurity and other livelihood shocks 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 potato harvest prior to 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.

### Capacity building

As a component of technologies promotion, training was provided for FFS group members at each district on potato production, disease & insect pest protection and postharvest management techniques following the cropping calendar on farmer’s field practically. During the intervention we managed to organize totally about 36 FFS out of which 16 Wolmera, 9 Adea-Berga and 11 Ejere, respectively having 889 farmers and 40 agricultural experts were also trained (Table 3). Experiences to date indicate that, the training of farmers on the use of healthy seed tubers and other aspects of integrated disease management is crucial for sustaining the availability of clean and healthy seed tubers (Gebremedhin et al., 2015). As a result, the number of farmers and groups involved in seed and ware potato production is expanding rapidly which helps to disseminate improved technologies. During the activities, farmers received consecutive training on integrated disease and pest management as well as post harvest handling of their produce via the construction of DLS. Thus, eight DLS was constructed by seed growers that encouraged farmers to save their own seed for more than eight months. The stored seeds were eventually used for next planting and for sale especially for ware production. Market linkage for seed tubers and ware tubers were created which enables sustainable seed production for FFS group members. Women farmers were trained on preparation of different foods from potato by technician from HARC.

**Table 3. Number of farmers trained on seed production, 2013–2015**

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

Another success of the group farmers were in all the districts the FFS members have been organized field days on their own initiatives and cost with districts BoA. Each year about three field days were organized and more than 1500 pamphlets were distributed for large number of farmers invited from neighboring districts and Kebeles that would help fast adoption of the technologies. This has helped farmers link to markets as the field days/open days are visited by several farmers’ representatives of governmental and non-governmental organizations. The regional and national median with different local languages also broadcast the field days, which helps to reach a larger audience.

### 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 late blight and the farmers used local potato varieties which has low yielder. During August to October, farmers face food shortage and travel to far areas to work as day laborers. But through the intervention of late blight tolerant potato varieties introduced and farmers can now produce food during the hunger period, thus making them food-secured during hunger months where other cereals are immature for consumption and also got additional income from potato sell to send their children to school. The FFS group members witnessed this by saying that, “We have been able to increase our food stock in the month of October because of potato”. In addition to food security, several farmers have increased income

from the sale of seed and ware potato, which has helped to improve their living standard in the three districts. As income of the farmers increase, most of them have saving accounts at different banks. After the intervention, potato production has improved household food security, nutrition quality, income diversification, and overall quality of living of the farmers who participated directly and indirectly through different communication.

### Conclusion and recommendations

The establishment of community based seed tuber production and supply scheme in the region is critical to improve potato yield and potato seed tuber quality, which are prerequisites to raising the level of farm income and smallholder producers' livelihoods. In the intervention districts, potato has become one of their main outfield crops. Farmers used to produce less than 8 t ha<sup>-1</sup> from local potato varieties where as currently they able to produce an average of 26 - 34 t ha<sup>-1</sup> in the main production season using quality seeds. The dissemination and adoption of improved technologies and good quality starter planting material increased seed potato production and productivity and creates awareness that use of quality seed have its own advantages to reduce disease like bacterial wilt and viruses. 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 to 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 strengthen the existing informal seed system and thus enable small-scale farmers to easily access potato seed at local levels. The Bureau of Agriculture, cooperatives office, and NGOs are expected to exert more concerted effort in organizing farmers at local level for potato seed production and marketing. 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 farm level;
- Farmers are willing to invest for the construction of DLS as indicated by the number of DLS constructed without support;
- Use of different media such as pamphlets/leaflets, National radio & TV helps to create awareness on 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 FFS or cooperatives helps to reach more farmers in technology dissemination with in short period of time than doing with individuals;

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