

Sustainable Seed Potato Production in Ethiopia: from Farm-Saved to Quality Declared Seed

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Introduction

In potato production, seed quality is an important determinant for the quantity and quality of the tuber yield (Struik and Wiersema, 1999). Current yields in Ethiopia are low (8 t ha⁻¹) but could easily be doubled or tripled. Perhaps the most significant constraint to increasing productivity and overall production is the chronic shortage of good quality seed tubers. Seed systems can be defined in the way farmers produce, select, save and acquire seeds (Sthapit *et al.*, 2008). In the absence of a commonly agreed definition for different seed systems, this paper will differentiate between three different types of seed production systems, i.e. formal, alternative and informal seed production systems.

The formal system involves seed certification by Ministry of Agriculture according the Ethiopian Standard for Seed Potato (ES 494:2005). The legal framework for a formal root and tuber seed certification scheme is in place but not implemented. Given the Ethiopia's large area size, the still limited road infrastructure and the fact that seed potatoes are being produced by hundred-thousands of small-scale farmers (instead to few large-scale commercial producers), the costs for implementing a formal seed certification scheme would be prohibitively high; so the logistic requirement is extremely challenging. It is therefore unrealistic to assume that such a system could be under operation at a national level in medium term. However, it might be feasible to certify seed produced by these few large-scale producers; particularly for those aiming at exporting potato seed to neighboring countries.

In the alternative system, farmer cooperatives and farmer groups (farmer cooperatives in the following) with technical support and supervision from the national research and extension system produce seed of relatively high quality, in the same way by special projects and universities. In contrast, the informal system is characterized by the absence of quality control mechanisms. Relatively poor quality seed, derived from farmers' own fields (farm-saved), and local markets or neighbors is planted for an unspecified number of generations.

According to (Gildemacher *et al.*, 2009), the informal system is the predominant seed production system accounting for 98.7% of the total potato seed produced in the country while the alternative system meets 1.3% of the national seed requirements and no certified seed is being produced at present. To put these percentages into perspective, the quantities of seed involved should be considered. The total area cropped to potato in Ethiopia is around 160,000 ha (Gebremedhin *et al.*, 2006). The annual seed requirement is therefore around 320,000 tons; out of which 315,840 tons (98.7%) are supplied by the informal seed system and the remaining 4,160 tons by the alternative system.

The informal and alternative seed systems will therefore remain to be the dominant seed production and dissemination mechanism in the country for the time being. Interventions designed to improve farmers' access to quality seed at affordable prices should therefore aim building upon the existing two systems, trying to improve seed quality and overall system efficiency. It is the purpose of this paper to provide an outline on how the alternative seed system could be strengthened by building upon the informal system and by introducing the concept of quality declared planting material (QDPM).

Improving farmer access to affordable quality seed

Seed quality is an important determinant for tuber yield and quality. The national research system and Solagrow PLC, a private company, are now producing potato minitubers (Generation 1 – G1 seed). While in 2011 less than 60,000 minitubers were produced, and it is likely that the total production in 2012 may exceed 300,000. The question remains, though, how could more than 2 million potato growing households benefit from this high quality seed, the minitubers.

A centralized approach whereby G2 (generation 2) and G3 (generation 3) seed is produced at only a few locations would involve huge logistic and cost to make this seed available to potato farmers in major rural seed production areas. This calls for a more decentralized seed production and multiplication system that is presented in the following. It links producers of pre-basic minitubers with farmer-based seed multiplication and dissemination systems, thereby creating a new hybrid system that incorporates components of the alternative as well as informal seed systems. Such a system would have the potential to give large numbers of potato farmers' access to quality seed.

Figure 1 illustrates the envisaged scheme for potato seed multiplication. The initial source materials are disease-free in-vitro plantlets produced by the national research system and private tissue culture laboratories. These plantlets are grown

in greenhouse or the newly built aeroponics units to produce pre-basic minitubers (G1). Given the small size of the pre-basic minitubers, experienced seed potato producers with under semi-controlled condition to give G2 seed should then multiply these; access to irrigation is an important requirement at this stage. These experienced multipliers include research centers, private enterprises, and leader farmers, ideally located at head points of traditional seed systems. These G2 seed is then sold to seed producer cooperative/ private sector multipliers who in turn may sell the subsequent generation to surrounding farmers: seed produced groups and private sector multipliers through farmer-to-farmer exchange. It is assumed that for the first two generations the entire produce would be kept as seed, however, as of generation three it is likely that an increasing proportion of the produce will be sold or consumed as ware immediately after harvest to satisfy farmers need for cash and food. It is difficult to assess for how many generations the seed will be recycled before used as seed for ware thereby reaching the consumer as ware potatoes. However, given experiences from other high-altitude areas, it is assumed that the seed could be multiplied for five to eight generations, especially if positive/negative selection techniques would be employed.

Farmer Cooperative and Model Farmers located in these seed producing areas play a key role in producing quality seed, catering for their own seed needs and providing seed to other growers operating in that area. Such a system requires more input/ resources initially, however, once established, it may drastically reduce transaction costs and dependence on outside intervention and functions in a sustainable manner. The small volume pre-basic minitubers (5 to 20 g) ideally complement such a system, since they can easily be transported to remote multiplication sites located at head points of these seed flows. This again greatly reduces potential transport bottlenecks of more centralized systems. For such a system to make best use of these expensive minitubers, it is important that the head points of these seed flows are located at high altitudes where disease pressure is greatly reduced. Subsequent seed generations should then gradually move to lower altitudes and ware crops can be grown in the lowlands. Minitubers are currently multiplied at research centers (Holetta, Adet, and Mekelle) to produce G2 seed tubers. However, initial tests to multiply minitubers by farmer cooperatives are encouraging; for example, during the Meher season of 2011 farmers in the Gurage zone managed to successfully multiply these minitubers. Out of 1000 G1 minitubers, they produced 10,650 G2 tubers. This is an excellent multiplication ratio of above 10 - a multiplication ratio of 6 to 8 was considered standard. This result show that farmers cooperatives are capable of successfully multiplying minitubers and the production of G2 seed that could be further decentralized into major seed producing areas.

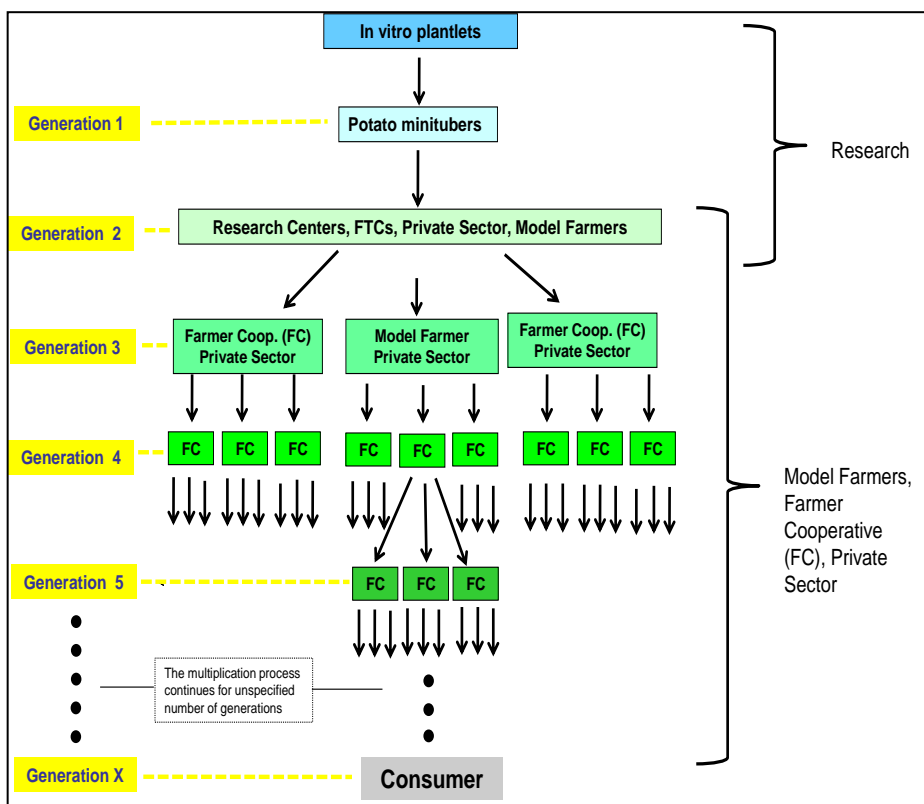


Figure 1: Decentralized seed multiplication scheme

Seed potato value chain

Seed and ware potatoes are distinct commodities that need to be treated differently from planting to harvesting and then storage. However, in Ethiopia value chains for these two commodities are largely identical. In the absence of a labeling system, it is difficult to distinguish seed tubers from ware potatoes in the market. A value chain analysis found that most seed potatoes sold in markets are simply graded and re-classified as ware potatoes. “Clever” traders, therefore, buy ware potatoes, declare them as planting material, and eventually sell them to farmers and other buyers / NGOs. Given this uncertainty, buyers of seed potatoes are reluctant to pay premium prices needed to justify the extra costs associated with the production of quality materials. It will therefore only be possible to establish separate value chain for seed potato if the following two pre-conditions are fulfilled:

- Seed potatoes are clearly recognizable as such in the market; and
- Buyers of seed potato are assured that they purchase unadulterated, high quality planting material.

Labeling

The first pre-condition is relatively easy to implement by introducing a labeling scheme for seed potato. Such a scheme is currently being piloted by EIAR, TARI, SARI and the BoAs in SNNPR, Oromia and Tigray with support by the “Wealth Creation” project, funded by the Common Fund for Commodities and the “Better Potato for a Better Life” project with USAID funding. Quality seed potatoes are produced and stored by seed producer cooperatives under supervision of research and extension staff. At the time of sell, paper labels are provided to the cooperatives and attached to the seed bags. The labels state the name and address (including telephone number) of the cooperative, the variety, weight and date of harvesting. An example of such a label in Amharic and English is shown in Figure 2. The initial experiences are encouraging as the scheme helps to link seed producers and buyers and contributes to the branding of the producers. Cooperatives consistently producing good quality seed will become known in their region and customers are more likely to return in future.



Figure 2: Labels of potato seed in Amharic and English

Seed Quality Assurance

In the absence of an operational seed certification scheme, seed tuber quality described as in the alternative system is maintained by staff of research organizations and seed potato projects whose jointly ensure the minimum quality standards. However, as the demand for quality seed is growing, this system is gradually reaching its production limits. Moreover, in case where it relies on projects' interventions it is not sustainable. Alternative mechanisms at regional and/or local level need to be developed, tested, and promoted to ensure that the producers of planting materials adhere to minimum quality standards.

Quality declared planting material

Ensuring that farmers have timely access to seed and planting material of good quality is one of the most important elements of successful agricultural production and development. Despite this reality, seed and planting material available to small-scale farmers in many parts of the world is often of insufficient quality, negatively affecting yields and undermining crop performance. This bottleneck is particularly acute in countries where small-scale producers dominate the production system and where fully-fledged seed certification schemes are not a viable option because of their high costs and logistical requirements.

To address this bottleneck, FAO, in consultation with partners, produced a technical guideline on Quality Declared Seed (QDS) in 2006 for crop species propagated by true botanical seed. These guidelines are now used and consulted worldwide (FAO, 2010). However, vegetatively propagated crop species have not been included in the QDS guidelines, despite their importance for agricultural production and food security. Therefore, FAO, in consultation with CIP and international experts, has developed protocols and standards for the production of Quality Declared Planting Material (QDPM) of the most important vegetatively propagated crops such as potato, sweetpotato, cassava and yam more recently (FAO, 2010). It is the aim of the QDPM guidelines to raise the physiological and phytosanitary quality, and hence, yield potential of planting material available to small-scale farmers, thereby increasing agricultural productivity. The QDPM protocols allow for easy and low cost inspection of planting material and facilitate the production of planting material that fulfills agreed on quality standards. The assessments are based on visual observations made by trained farmers, research, or extension personnel.

The QDPM guidelines need to be adapted to the prevailing conditions and available resources. The underlying principle is shown in Figure 3 as a function of “inspection costs” and “seed quality”, assuming a decreasing marginal benefit with increasing intensity of seed inspections. The best quality seed will be attained with a formal seed certification scheme, however, as discussed earlier, such a system is currently not a viable option for potato seed production in Ethiopia due to its costs and logistical requirements. Therefore, an acceptable compromise between cost and seed quality needs to be found. “QDPM light” refers to a minimum inspection intensity already resulting in tangible seed quality improvements while “QDPM intense” refers to a more sophisticated but also more expensive inspection regime.

The QDPM concept does not intend to replace seed certification schemes. Rather it should be considered as an intermediate step towards the establishment of a

certification scheme. As soon as conditions and resources allow it, the inspection intensity should be increased to further improve seed quality. The Government of Ethiopia is very much cognizant of the need to improve the quality of seed and planting material for achieving the ambitious targets set for agricultural growth in the current five-year plan. Recognizing that formal seed certification schemes may currently not be attainable, the QDPM concept forms part of the policy recommendation produced by the Agricultural Transformation Agency and is included in the new national Seed Proclamation.

QDPM guidelines for potato: An example

Based on the FAO guidelines for QDPM, the following production guidelines for quality declared potato seed tubers are suggested

- Isolation: the seed potato crop should at least be 50 m apart from the next ware potato crop; and
- Crop rotation: At least a 3-year crop rotation should be maintained ensuring that the previous 2 years no solanaceous crops were produced on the seed potato plot

At least one field inspection should be carried. In fields of less than 2 ha, 10 counts of 100 plants each are taken. The plants should be assessed based on the tolerances listed in Table 1. Aphid counts should be taken on all assessed plants. In case of a slight infestation (1 to 2 aphids on few plants), no measures need to be taken. In case of moderate infestation (2 to 5 aphids on most plants), the crop should be treated with an insecticide. In case of a severe infestation (>than 5 aphids on most plants), the crop should be treated with an insecticide and early haulm destruction is recommended. In addition, a post-harvest inspection should be carried out to ensure that the stored seed is graded to agree on seed sizes (e.g. 35 to 70 mm), the seed is stored in diffused light stores, is reasonably free of soil and that different varieties are kept apart.

Examples for tolerances for pests, diseases and other criteria for the field and post-harvest inspection are given in Tables 1 and 2. These tolerances would still need to be reviewed and adapted to the conditions/ constraints on the ground. Important is, however, to ensure that the selected indicators can be assessed through visible observations by trained persons (farmers, research and extension staff) without the need for expensive laboratory testing. The threshold levels need to be realistic and attainable by reasonably trained and experienced seed producers. If the tolerances are too strict, farmers will be discouraged to continue with the system, falling back to the informal system without any quality control. These guidelines would need to

be adapted to the envisaged seed quality requirements, the inspection intensity and resources available for the inspections.

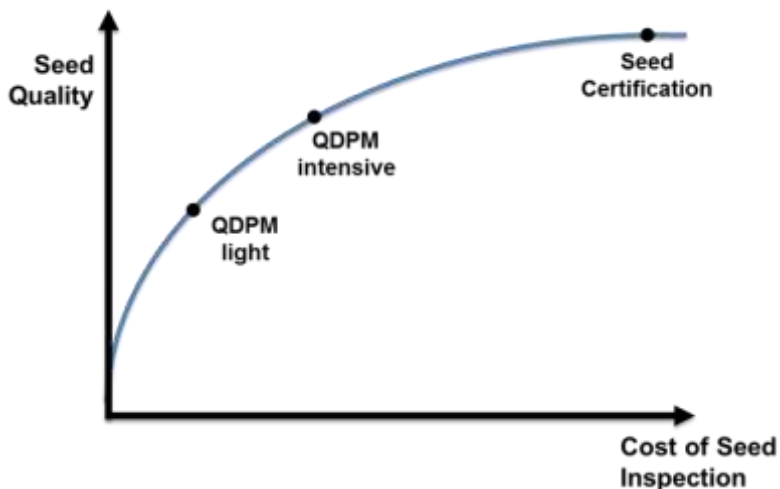


Figure 3: Schematic illustration of the effect of different seed quality control mechanisms on inspection costs and seed quality

Table 1: Example tolerances for the field inspection of QDPM seed plots

Disease or defect	Tolerance
Off-type potato plants	1%
Leaf roll (virus)	5%
Severe mosaic (virus)	5%
Total severe virus (leaf roll + severe mosaic)	10%
Mild mosaic (virus)	10%
Total virus	10%
Blackleg	2%
Bacterial wilt	nil

Table 2: Example tolerances for the post-harvest inspection

Disease, pest or defect	Tolerance
Wart disease (<i>Synchytrium endobioticum</i>)	Nil
Late blight (<i>Phytophthora infestans</i>)	5%
Powdery scab (<i>Spongospora subterranea</i>)	8%
Tuber necrosis caused by strains of PVY	0.5%
Soil (by weight)	2%
Off-type seed tubers	1%

Inspection mechanism

Depending on the inspection intensity and, of course, availability of resources, two separate inspection mechanisms could be envisaged, roughly corresponding to QDPM light and intensive, as shown in Figure 3. The QDPM light would correspond to a self-inspection scheme implemented by seed producer cooperative themselves without direct outside support and follow up. Examples of such self-inspection teams already exist in the country. Seed producer cooperatives around Holetta who have been supported by EIAR for several years have established internal inspection committees consisting of 3 to 6 members of the cooperative (Gebremedhin, pers. comm.). They visit the seed plots of all members and decide based on visual observations whether a certain plot fulfills the cooperatives requirements/ tolerances for seed production. In some cases, the cooperative even compensates members if their seed plot is rejected to encourage the farmer to comply with their recommendation to sell the produce for consumption purposes. These examples clearly show that cooperative-level inspection systems are a farmer-acceptable and a viable option for low-level, informal seed inspection schemes (QDPM light). Building on these existing experiences, the system could be strengthened by agreeing on and applying uniform tolerances for pest and diseases and by training the self-inspection teams. Subsequently the system could be promoted and applied in other seed producing areas of the country.

The QDPM light system could be further strengthened and formalized by establishing a second inspection committee, operating at woreda level (QDPM intensive). This committee should involve staff of research and development institutions present in the woreda and 1 or 2 representatives of the seed producer cooperatives. It may not be possible for this committee to inspect all seed plots in the woreda. Instead a sample of all seed plots of a cooperative would be inspected. Depending on the available resources, the seed plots may be inspected once or twice during the growing season, in addition, a post-harvest inspection should be

carried out to ensure that the seed is graded, stored in adequate conditions (diffused light stores), and that different varieties are clearly separated.

The woreda-level committee should then estimate the total quantity of seed the cooperative has produced for sale. Based on this estimate, the committee provides the corresponding number of seed labels to the cooperative for the seed produced during this particular season. In addition, the cooperative should be awarded the title of “Recognized Seed Producer” for a given period and should be authorized to market its seed as QDPM seed.

Footing the bill: who is going to pay for the inspections?

Production costs of quality seed potatoes are substantially higher than ware potatoes. This is explained by the fact that yields of seed crops are generally lower than ware crops and by extra costs associated with rouging, dehaulming, and grading. In addition, seed tubers lose between 3 to 4% of weight during storage in diffused light stores (Endale *et al.*, 2008) and farmer runs the risk of not being able to find a buyer for his seed. The inspection itself (transport, per diems, and accommodation) and the labels for seed potato bags increase the costs of QDPM seed even further.

These costs may initially be borne by special projects supporting seed potato value chain; however, ultimately they need to be incorporated into the seed price paid by the buyer. To convince seed buyers that quality seed justifies the extra cost, substantial efforts in advertising and awareness creation, ideally in combination with field demonstrations by showing that quality seed does translate into visibly better yields and hence justifies the initial investment should be major activities at present.

In this context a word of caution: The formal Ethiopian seed potato market is unique in the sense that it is dominated by institutional buyers (NGOs, MoA, EIAR, FAO and aid agencies). Farmer to farmer seed exchanges (gifts, bartering) does take place, however, only limited quantities of seed are being sold directly between farmers and neighbors. In the absence of well-established value chain for seed tubers, it is very difficult to assess the actual demand for quality seed. Therefore, efforts to produce quality seed would need to be matched by efforts to link producers to either institutional or private buyers of quality seed.

Seed potato vision for 2020

The Ethiopian potato subsector is vibrant, the potential of this crop to contribute to improved food security and nutrition are increasingly being recognized and future prospects for the seed potato subsector are bright. This is exemplified by increasing donor interest in the crop (viz Irish Aid) and the fact that the Disaster Risk Management and Food Security Sector (DRMFSS) of the Ministry to Agriculture has just created a task force for root and tuber crops to exploit the potential in emergency situations.

For the year 2020, the author's vision for the Ethiopian potato sub-sector would be that average potato yields have doubled and overall production has tripled. Self-financed, sustainable seed inspection system applying QDPM standards function without outside support in all major seed producing areas. QDPM seed meets at least 50% of the national seed demand. In addition, a formal seed certification scheme is in place for large-scale commercial seed producers. The involvement of NGO and government agencies into purchasing and distribution of seed tubers is greatly reduced as seed is traded directly from farmer to farmer and seed exports into neighboring countries generate appreciable amounts of foreign currency. An internet or mobile phone based information exchange platform is established, effectively linking seed producers and buyers and providing up-to-date market price information.

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