Roadmap for Investment in the Seed Potato Value Chain in Eastern Africa

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Roadmap for investment in the seed potato value chain in eastern Africa

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ACRONYMS

ACTESA	Alliance for Commodity Trade in Eastern and Southern Africa (COMESA)
AFSTA	African Seed Trade Association
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CFC	Common Fund for Commodities
CIP	International Potato Center
COMESA	Common Market for Eastern and Southern Africa
DLS	Diffused light store
FAO	U.N. Food and Agriculture Organization
FTF	Feed the Future
HDI	Human Development Indicators
IA	Investment area
M&E	Monitoring and evaluation
MT	Metric ton
NARS	National agricultural research systems
NGO	Nongovernmental organization
PMCA	Participatory Market Chain Approach
PS	Positive selection (positively selected)
QDS	Quality Declared Seed
RMT	Rapid multiplication technology
SME	Small and medium enterprise
SSA	Sub-Saharan Africa
SWOT	Strengths, weaknesses, opportunities, threats
USAID	U.S. Agency for International Development

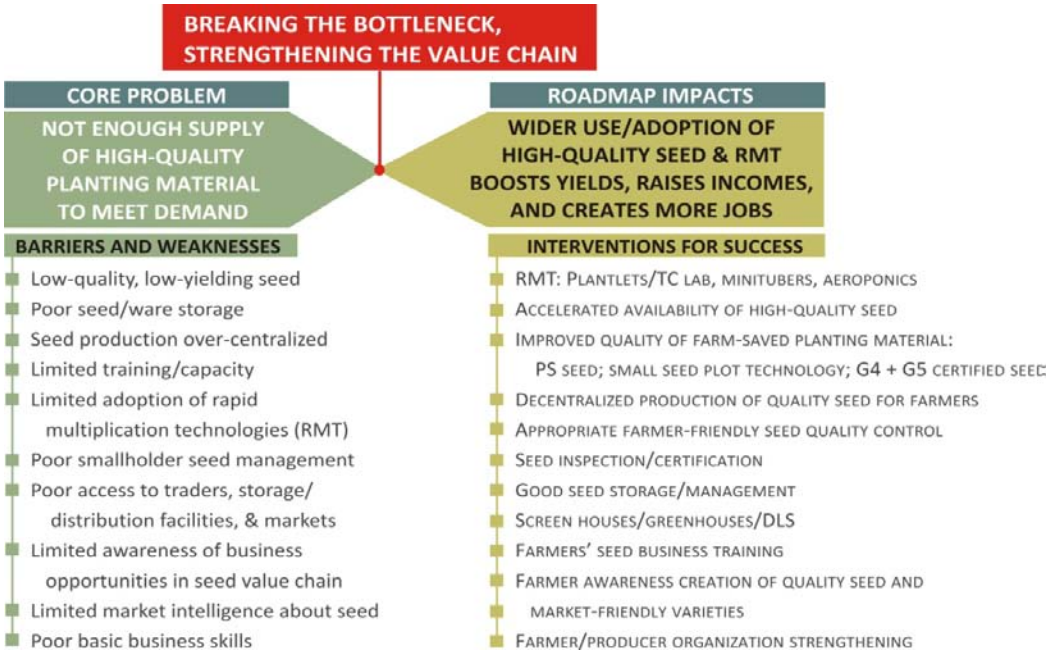
NOTE

The ideas and strategies presented in the Roadmap reflect months of active discussion and consensus by a number of seed potato scientists, value chain specialists, and various private and public sector actors who are deeply committed to improving the livelihoods of small-scale farmers in eastern Africa. CIP extends its thanks to all of these people and to USAID for funding this initiative. The Roadmap document was prepared by a core team of writers—Graham Thiele, Ricardo Labarta, Elmar Schulte-Geldermann, and Gary Harrison—supported by Greg Forbes, Meredith Bonierbale, Berga Lemaga, and Oscar Ortiz. The Roadmap greatly benefited from the insightful observations and recommendations by Robert Tripp, who served as an external peer reviewer of an earlier draft. José Torres designed the document's cover and standalone briefing note. CIP also acknowledges the special contribution of Dr. Ian Barker, who led the 3G project and was instrumental in shaping the vision for a dynamic seed potato value chain in eastern Africa and promoting the potential of high-quality seed and rapid multiplication technologies.

EXECUTIVE SUMMARY

Potato production in Sub-Saharan Africa (SSA) has more than doubled since 1994, with 70% of that growth concentrated in eastern Africa (FAO and CFC 2010). Despite these gains, potato yields of small-scale farmers in the region fall far short of their potential due mostly to a potent combination of inadequate supplies of high-quality seed and smallholders' limited awareness of better seed management practices.

Greater involvement by the private sector in seed potato value chains offers a means to unlock this yield gap by overcoming the supply bottleneck that is limiting the provision of quality seed (see figure). A more efficient and responsive seed system will improve production, distribution, use, and profitability for farmers. Promising rapid multiplication technologies, the "3G revolution," and an engaged private sector can provide needed capacity to broaden adoption of quality seed and accelerate availability of new varieties with more prospect of added value. Better integration of national agricultural research and extension systems into the value chain, as well as farmer training schemes in seed management and storage, can stimulate innovation. A regional perspective can help exploit economies of scale for sharing knowledge and technology, implement creative applications of information communication technologies, advocate for farmer-friendly seed-related regulations and policies, improve the business-enabling environment, and expand intra-regional trade for seed of the highest categories.



Summary of core problem addressed and projected impacts of Roadmap.

The five-year strategy described in this Roadmap document for Ethiopia, Kenya, Rwanda, Tanzania, and Uganda targets business investments in key areas along the seed potato value chain to increase the availability of high-quality seed potatoes from less than 1% to at least 5% of demand (except Kenya, where the target is 10%) and promote improved seed management. This will raise incomes of smallholder farmers, improve food security, and add to the rural and growing urban economies in these five countries. The focus areas and approaches presented in the Roadmap are consistent with those laid out in USAID's comprehensive Feed the Future (FTF) initiative and are supportive of development themes and programs of other multilateral donors.

Five mutually reinforcing core investment areas (IAs) are proposed to put the seed potato value chain interventions into practice. Three IAs make up country-level business plans:

1. **Improving** quality seed production and distribution
2. **Enhancing** profitability of quality seed use
3. **Upgrading** value chain coordination.

Two IAs are regional and potentially cross-cut all five countries:

4. **Promoting** regional networks for sharing knowledge and best practices
5. **Growing** intra-regional trade in seed.

The IAs build on a mix of value chain fundamentals and the accomplishments and lessons learned from recent projects, such as the two-year, USAID-funded 3G project. Led by the International Potato Center and implemented in Kenya, Rwanda, and Uganda, the 3G project increased access to and production of basic seed potato in both public and private sectors; successfully introduced aeroponics technology and supported its adaption and adoption; and significantly increased production of minitubers at the national and regional scales. The project fostered private adoption of the three-generation (hence the "3G") seed multiplication strategy and improved knowledge and skills leading to average yield increases of 20% for over 15,000 smallholder growers on potato production technologies and best practices. Other seed-related projects have generated complementary experience with improving farmer seed management that can be scaled up, such as the Common Fund for Commodities project in Uganda, Kenya, and Ethiopia and the Irish Aid-funded project in Malawi. The investment of $15 million proposed in the Roadmap is expected to generate a net present value of $128.7 million and an internal rate of return of 156%. It will lead to increases in yields of 20% in the five target countries to achieve three overarching objectives: a 15% increase in farm incomes, improved food security through a 10% increase in potato production, and more business opportunities for at least 240,000 households of smallholder potato growers.

1. INTRODUCTION AND BACKGROUND

1.1 The Investment Opportunity

In 2010, the International Potato Center (CIP) received a grant from the U.S. Agency for International Development (USAID) to develop a "Roadmap" for developing commercially sustainable quality seed production in eastern Africa. As presented here, the Roadmap lays out a five-year strategy for targeting business investments in key areas along the seed potato value chain in Ethiopia, Kenya, Rwanda, Tanzania, and Uganda. The overall objectives of this strategy are to *improve productivity, raise incomes of smallholder farmers, enhance food security, and grow the rural and urban economies in these five countries*. The focus areas and approaches proposed in the Roadmap are consistent with those discussed in USAID's comprehensive Feed the Future (FTF) initiative and are supportive of development themes and programs of other multilateral donors.

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The background to this investment is laid out in the rest of this chapter. Chapter 2 describes the quality seed potato value chain and bottlenecks to its improvement. The activities and outputs and the size of investment anticipated for each IA are mapped out in Chapter 3, followed by a description of the expected impacts in Chapter 4. Additional information is found in the two supporting annexes.

1.2 The Roadmap Countries and the Importance of Potato

The five Roadmap countries are among the poorest in the world, with per capita GDP between US $992 and $1,628; most are close to the bottom 169th country in the ranking. They have a high percentage of food-insecure population and low levels of nutrition, education, and other human development indicators (Table 1.1). Large segments of the population in these countries live below the poverty line (35.7–56.9%), with Rwanda having the highest proportion in poverty. In Ethiopia 41% of its population is undernourished, and 34.6% of the children under five years is underweight.

Table 1.1 Human Development Indicators in the Roadmap Countries

Indicators	Ethiopia	Kenya	Rwanda	Tanzania	Uganda
GDP/capita (US$)	992	1,628	1,190	1,224	1,334
Global ranking income/capita	159	118	153	148	138
Population below poverty line (%)	44.2	45.9	56.9	35.7	37.7
Population undernourished (%)	41	31	34	34	21
Children 0–5 years old underweight (%)	34.6	16.5	18.0	16.7	16.4
Human Development Index (HDI)	0.328	0.470	0.385	0.398	0.422
Global ranking (HDI)	159	128	152	148	143

Potato, an important crop in these five countries, is increasingly important for production and consumption. It ranks second in both Kenya (after maize) and Rwanda (after banana). The target population in the Roadmap countries includes around 4 million potato growers with 620,000 ha producing 3,600,000 metric tons (MT) of potato for consumption (Table 1.2).

Table 1.2 Average Potato Production and Consumption in the Roadmap Countries

Indicators	Ethiopia	Kenya	Rwanda	Tanzania	Uganda
Production (MT)	940,087	845,984	1,157,217	580,548	621,714
Area (ha)	164,146	126,468	130,392	106,578	90,000
Yields (MT/ha)	5.72	6.81	8.87	5.32	6.91
Number of farmers	1,869,236	800,000	720,115	426,315	240,000
Country population	74,704,880	35,877,000	9,032,459	39,052,180	28,728,270
Consumption (MT)	833,388	787,650	1,080,374	475,439	407,111

Note. Indicators are average of FAOSTAT statistics for the period 2002–2007 in order to incorporate fluctuations in area and production. Number of farmers is the most recent estimation.

Compared with other staple crops in the target five countries, potato has gained importance in the last 20 years. Potato production and area grew between 1991 and 2007 at an annual rate of 4.6% and 5.2%, respectively, with Tanzania and Rwanda showing the highest growth (Table 1.3). Potato grew much faster than the staples maize and cassava. In terms of the potential of potato as a cash crop, there is a fast-growing ware potato market owing especially to an increased processing industry with specific quality needs (Tesafaye et al. 2010). This demand will further strengthen the market for seed potato of varieties suitable for processing.

Table 1.3 Production, Area, Yields, and Food Supply Growth Rates of Potato and Other Main Crops in Five Countries (1991–1993 to 2005–2007)

Crop	Item	Country					
		Ethiopia	Kenya	Rwanda	Tanzania	Uganda	Total
Potatoes	Production	1.7	1.0	9.5	10.0	5.8	4.6
	Area	2.5	3.8	7.4	10.0	6.4	5.2
	Yield (t/ha)	-0.7	-2.7	2.0	0.0	-0.6	-0.9
	Food supply quantity (t)	1.7	0.7	11.2	9.9	5.8	4.8
Maize	Production	7.0	2.0	0.1	2.9	4.4	3.8
	Area	4.0	1.9	3.7	2.9	4.3	3.0
	Yield (t/ha)	2.9	0.1	-3.5	0.0	0.1	0.8
	Food supply quantity (t)	5.3	2.3	0.1	0.9	4.5	2.9
Cassava	Production	0.0	-0.7	6.6	-1.7	3.7	0.6
	Area	0.0	0.4	-0.3	2.3	0.2	1.4
	Yield (t/ha)	0.0	-1.1	6.9	-3.9	3.5	-0.8
	Food supply quantity (t)	0.0	-0.7	6.7	-2.4	2.5	-0.5

Whilst production and area increased, potato yields actually declined over this period (Table 1.3). Mean yields in these countries range from 5.3 to 8.9 MT/ha—far short of the potential for small-scale farmers to realize around 25 MT/ha. The most important factor limiting yields is that most small farmers continue to use poor quality seed, a finding common throughout SSA (Gildemacher et al. 2009). This in turn is a function of the limited availability of quality seed and of farmers' limited awareness of optimum seed management practices that could maintain quality.

1.3 Synergies with USAID Initiatives

The Roadmap's focus on the seed potato value chain in eastern Africa, the five IAs, and overall objectives all have direct relevance and applicability to USAID's FTF initiative (Fig. 1). *Foremost is the shared goal of improving food security and reducing poverty of smallholder farmers whose incomes are limited by low productivity and poor market access*. The FTF notes that improved technologies (e.g., pest-resistant varieties, improved seeds, better soil management) can double yields. Consistent with the FTF, the Roadmap seeks to draw in private sector partners to open up markets through investment in quality seed potato, building farmers' entrepreneurial capacity, and inter-regional trade: "Following seed sector liberalization, Kenya has many vibrant private seed companies competing to make improved varieties available to farmers, and Uganda's seed sector is developing rapidly. Bringing these benefits to smaller countries like Rwanda can be accelerated by focused partnerships to encourage private investments" (USAID 2010, p. 7). Support for the Roadmap IAs would be wholly consistent with FTF funds targeted for USAID/EA beginning in 2012.

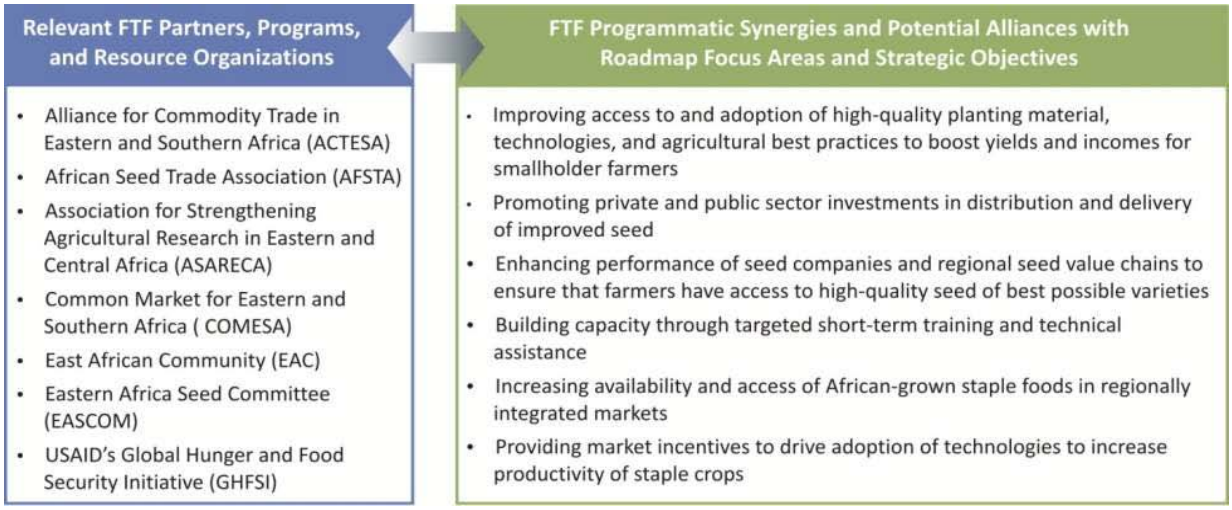


Figure 1 Synergies between USAID/EA's FTF strategies and the Roadmap IAs.

1.4 The USAID-funded 3G Seed Potato Project as a Model

The IAs described in the Roadmap reflect the science, practice, and lessons learned from the USAID-funded 3G seed potato project, which sought to improve the quality and distribution of seed potato for small farmers (Box 1). From 2008 to 2011, CIP and partners in Kenya, Rwanda, and Uganda increased national capacity to produce seed potato in both public and private sectors. Partners successfully introduced, adapted, and adopted rapid multiplication technologies (RMTs), including the use of aeroponics to produce minitubers. This attracted the private sector and significantly increased the production of minitubers at national and regional scales. *In Kenya alone, minituber production increased from 30,000 to 1,000,000 in 2.5 years* (Labarta and Mulwa 2011). Within the 3G project, basic and certified seed production rose significantly—from 65 MT (average 2005–2009) to an estimated 4,000 MT (in 2011) per year, mainly due to private sector seed multipliers. This represented an increase in the availability of certified seed from about 0.3% to about 6% within just two years, of which a considerable part was further multiplied by trained multipliers in the 20 main potato-growing districts of Kenya to make seed available locally to ware potato farmers. The targeted training of farmers was pivotal to the successful adoption and recognition of the importance of quality seed. The 3G project demonstrated that commercial producers and entrepreneurs, often engaged with other crops, can acquire the exacting technical skills required to produce quality seed potato. Extensive training of about 17,000 farmers in the Positive Selection (PS) method further increased the quality of seed used significantly on a national scale.

BOX 1. THE 3G STRATEGY: AEROPONICS

THE **3G** SEED STRATEGY relies on producing large numbers of minitubers through one generation of a very rapid multiplication technology (RMTs), allowing bulking of sufficient seed in only two field generations rather than the conventional four to six. This reduces both the cost of production and prevents the build up of damaging diseases in the field.

The main RMT method is **aeroponics**, which achieves multiplication rates of over 50:1 compared with the normal 5:1. Aeroponics involves producing minitubers from in-vitro cuttings in a totally enclosed darkened box into which water and nutrient are sprayed as a mist. Minitubers are harvested from the suspended roots. CIP has adapted this technology in Peru to lower its cost by reducing the cost of components and saving on water and energy usage.

So far, 11 aeroponics units have been established and produced 1.4 million minitubers in Kenya alone. Economic analysis showed that minitubers in aeroponics can be produced for about 20–50% of the cost of minitubers from conventional pot production systems.

Other Key Lessons Learned from the 3G Project

- Aeroponics and other RMTs can contribute to breaking the seed potato bottleneck by reducing the number of field generations of multiplication needed to get quality seed to farmers.
- Clean seed is a profitable investment for smallholder farmers, and farmers are willing to invest in certified seed.
- An efficient, agile, innovative private sector will invest in seed potato production.
- Transport of bulky seed potato is a major challenge, underscoring the importance of decentralized seed multiplication.
- With proper technical advice and backstopping, farmers are able to produce high-quality seed locally.
- How short-generation seed schemes relate to existing seed regulations and need to standardize across borders needs to be better understood.
- Seed movement and harmonization of variety registration/recognition across borders in the region are still not implemented.

1.5 Seed Potato Project Experience in Eastern Africa

The evidence for the Roadmap's investment strategy and IAs is not restricted to the lessons learned from the 3G project. CIP's recent, and ongoing, experience in implementing seed potato projects for USAID and other donors in the Roadmap countries has produced similar key findings that have helped shape the recommendations called for in this document (Table 1.4).

Table 1.4 CIP's Seed Potato Project Experience and Synergies Relevant to the Roadmap

Donor	Project	Key Findings
GIZ	*Establishment of the Aeroponics Technology in Seed Potato Multiplication in Kenya*	▪ Two aeroponics units, established and operated by small and medium enterprises, increased by over three times the annual production of disease-free minitubers ▪ Aeroponics and other RMTs helped break the long-standing seed bottleneck, increasing 5- to 10-fold the multiplication rate and reducing field generations from six to three ▪ The amount of basic seed production will likely increase from 80 tons in 2008 to 500 tons in 2012 ▪ Private sector profitably increased overall capacity of minituber, basic, and certified seed production and spread aeroponics technology to other interested private entrepreneurs ▪ Farmers were willing to pay more for certified, clean, and PS seed than for farmer seed

Donor	Project	Key Findings
Irish Aid	*Revitalizing Seed and Table Irish Potato Production in Malawi through Capacity Strengthening, Technology Development, and Public-Private Partnerships*	▪ Quality seed was produced faster and made available to farmers for increased productivity, food, and incomes ▪ Formal seed systems play a strategic role in injecting quality seed into the informal seed system ▪ Development of varieties and crop management practices that increase productivity is key factor for increasing profitability in potato industry and for attracting private investors into potato farming ▪ Aeroponics system outperforms traditional system
CFC*	*Wealth Creation Through Integrated Development of the Potato Production and Marketing Sector in Kenya, Uganda and Ethiopia*	▪ Convinced by high profits, farmers are willing to invest in clean/certified seed, which resulted in farmers' access to quality seed ▪ With proper technical advice and backstopping, farmers can produce high-quality seed locally: more than 2,700 farmers were trained in seed production and another 6,000 in farm management of their own seed ▪ Farmers are willing to invest in diffused light stores (DLS) without external support ▪ Hands-on training enabled farmers to apply PS, and together with improved agronomic practices, farmers improved their seed and increased yields by two- to fivefold, which in turn improved their household food security and income ▪ Seed and ware potato farmers were connected to markets, among others, through contract faming
USAID	*Better Potato for a Better Life*	▪ The highly decentralized seed multiplication schemes allow farmers in remote areas to gain access to affordable quality seed ▪ Quality seed needs to be clearly separated from ware potatoes through branding, labeling, and the creation of separate seed value chains ▪ Increased seed storage capacity (DLS) contributes to the establishment of sustainable seed systems ▪ During a recent six-month period, participating farmers harvested almost three times the national average, highlighting the potential for increasing farmers' yields through improved seed and management practices

*The Common Fund for Commodities.

1.6 Participatory Process, Vision, and Strategic Objectives

The Roadmap was prepared with extensive participation of partners, including public and private actors in seed value chains in each of the countries, and also regional actors such as the Alliance for Commodity Trade in Eastern and Southern Africa (COMESA), AFSTA (African Seed Trade Association, and Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). The participatory process built on the partnerships formed during the 3G project in Kenya, Rwanda, and Uganda, and began the creation of new ones in Tanzania and Ethiopia. The process included a series of facilitated workshops, which were sequenced to progressively build knowledge and consensus around the overall objectives and the five IAs. Contributions from partners continued into the writing process itself as writing teams from across the region provided input into and validated the Roadmap document.

CIP and partners from all five target countries held a two-day visioning and strategy workshop in Nairobi on 11–12 May 2011. Participants agreed on both a shared vision for the Roadmap—**"quality seed potato improving incomes and food security in Eastern Africa"**—and a set of strategic objectives to guide the Roadmap:

- To upgrade the value chain of seed potato production businesses and build capacity to continuously improve seed provision.
- To cover at least 10% of the total seed potato requirement with quality seed, including that of small farmers, by making it locally available in a commercially sustainable manner.
- To enable the private sector to assume a leading role in seed production and distribution without excluding the public sector.
- To strengthen the capacity of research and innovation systems to improve seed management and variety development.
- To enable farmers to effectively manage their seed quality to improve potato productivity and make more food available.
- To harmonize policies leading to cross-border trade in seed potato and exchange of varieties.
- To accelerate the availability, dissemination, and adoption of new varieties.
- To create sustainable linkages between seed and ware value chain.

2. THE SEED POTATO VALUE CHAIN

2.1 Value Chain Actors for Quality Seed Potato

In the value chain for quality seed potato (Fig. 2), linked actors produce seed potato of different generations, starting with pathogen-free seed from a laboratory and ending with use by ware producers. Seed moves from actor to actor across the chain, as the output of each generation of seed provides the input to the next, and money to purchase the seed moves in the opposite direction. A well-functioning value chain shows a high level of coordination as the supply of seed by each group of actors in the chain closely matches the requirements of the next group who uses it. Coordination is facilitated by a flow of information in both directions along the value chain, related to ware producers' needs for timely access, quantities, and quality and varietal preferences for seed. Sales and prices send clear messages along the chain about these preferences in a competitive market context. The value chain should be able to continuously innovate in response to changing opportunities and demands.

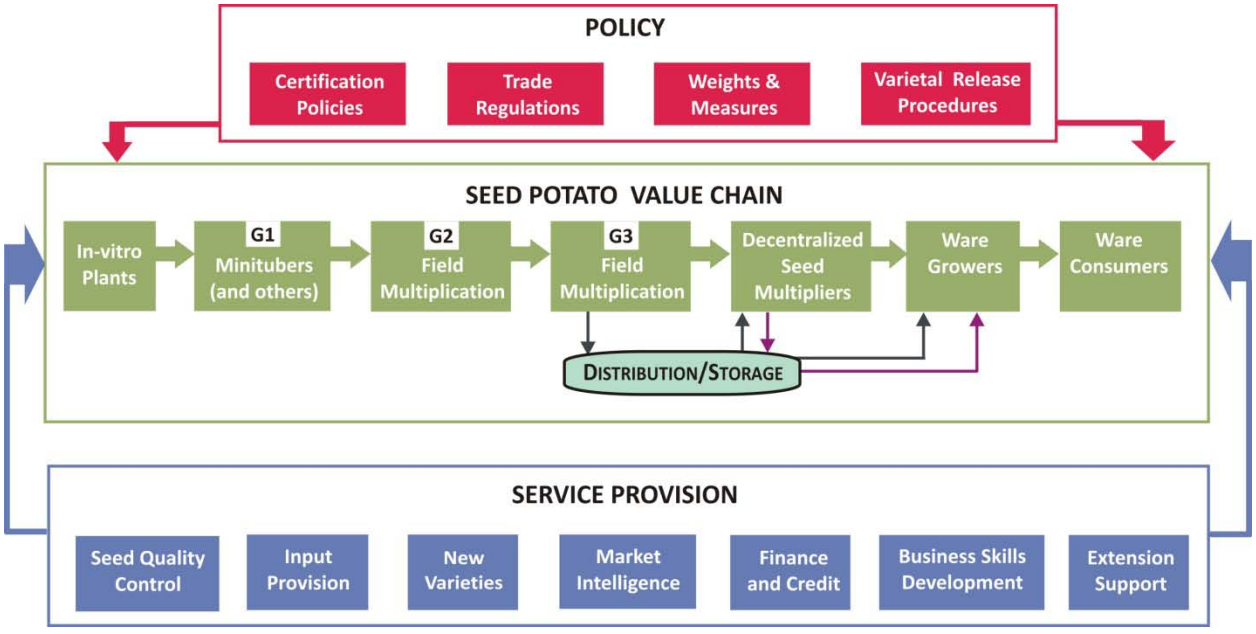


Figure 2 Seed potato value chain.

This process of providing quality seed along the chain takes several years. The scheme described here shows two field multiplications (G2 and G3) by specialized multipliers followed by distribution to decentralized seed producers for further multiplication. Because seed potato is bulky, transport costs are a significant component of final cost and multiplication should take place as close as possible to point-of-use by ware growers. Hence, distribution and storage are very important functions in providing seed to the decentralized multipliers and on to ware growers.

The value chain is supported by a series of services. One of the most important is quality control usually carried out through government agencies as a formal certification process. An alternative mechanism is Quality Declared Seed (QDS), where growers themselves manage procedures to provide high-quality seed. The provision of new varieties to the value chain is another important service, as the diffusion of new varieties is an important function of a seed system. Ultimately, the costs of all actors in the chain, including service provision, must be covered by the additional value generated through the use of quality seed by ware growers. The seed potato value chain is itself the starting point for the ware potato value chain. The market opportunities, needs, and profitability in the ware potato value chain drive the seed chain.

The policy environment shapes the kinds of transactions that occur within the seed value chain and the nature of service provision. Some types of policy that appear to be favorable to the use of quality seed, such as the mandatory use of certified seed, might lead to efficiency losses as they exclude other types of seed provision for cash-constrained or distant ware producers who cannot economically access certified seed.

The high return to the use of quality seed by the ware growers and the large amount of seed they need (with seed requirements of 2 t/ha) generates many business opportunities for decentralized seed potato providers to meet this need. These businesses are highly resource intensive with the need for specialized infrastructure and meticulous care over production processes in early generations and large amounts of land and labor needed for G3 and decentralized multiplication. In the Roadmap countries, government agencies typically lack sufficient resources for rapid scale-up. Significant increases in the use of quality, certified seed will require that private agri-business companies take a leading role in earlier generations, including minituber production and field multiplications, to complement existing public sector actors. An increased volume and efficiency of production with private sector involvement should reduce costs of production, providing better opportunities for commercial seed potato multiplication.

Experience from the 3G project suggests the following scheme for organizing seed multiplication in the value chain:

- **In-vitro production**. The first step is to strengthen capacity in public and private tissue culture (TC) laboratories for in-vitro plant production, and plant pathology laboratories to continuously monitor plant health, as a basis for the production of quality seed potatoes.
- **Minituber production (G1—"pre-basic")**. In the past, national programs normally produced minitubers in pots in insect-proof screen houses. Under the 3G project, the RMT aeroponics was successfully introduced. The technology increases the multiplication rate by about 8- to 10-fold, potentially reducing field generations from six to the three (see Fig. 2). Aeroponics contributes to breaking the long-standing seed bottleneck that prevents the potato value chain from achieving its full potential.

- **Field multiplication (G2 and G3—"basic"[1])** is done by highly specialized multipliers at locations suitable for seed multiplication, usually medium- to large-scale farms, mostly private with public backup system and related research.
- **Decentralized seed multipliers (G4 and G5—"certified" or QDS)** is done by trained farmers on small- to medium-scale farms; private with public backstopping system at high altitude locations with low disease pressure, who have sufficient land. This seed may be certified by a government agency or marketed as QDS. As the 3G project showed, decentralized field multiplication is crucial to lowering the cost of seed and improving seed availability to a large number of small-scale ware producers.

2.2 Bottlenecks and Risks to Developing Value Chain and Recent Progress to Address Them

2.2.1 Seed production and distribution

In a study to determine the effect of seed quality on seed in 22 on-farm trials in Kenya, Schulte-Geldermann et al. (2010) showed that high-quality 3G seed increased yields by 1.8–3.8 (average 2.6) times compared with farmers' seed and that every further field multiplication generation significantly reduced this yield gain, although it was still advantageous.

Despite this potential yield gain and high return, the use of high-quality seed is strongly limited by its availability. In Kenya for instance, certified seed sold in 2009, before the 3G project, was less than 1% of the estimated demand of 300,000 t/year. Another 2% of seed was produced by informal seed multipliers who multiply basic seed for one to three seasons before selling to ware potato producers (Kaguongo 2009).

In recent baseline studies (2009–2011), potato farmers in the region stated that limited availability of quality seed, high seed price (up to four times the ware price), and long distance to the source of quality seeds were principal limitations to the use of quality seed. Potato growers mostly chose to use seed from their own harvest with higher disease levels, or purchase seed from a neighbor or the local market. Only a small number accessed seed from a specialized clean seed multiplier. About 20% of farmers in Kenya reported replacing seed every 3–4 seasons from off-farm sources and paying twice (between 1.6 and 3.2) the ware price for new seed. This represents a potential demand for better seed, if it can be provided locally at affordable prices, and reveals a considerable business opportunity for seed potato entrepreneurs.

In eastern Africa, high-quality seed potato production up to certified seed is traditionally mandated to public sector research organizations. Increasing the volume they produce may be difficult as their mandates are not designed to take entrepreneurial risks for profit and their comparative advantage lies in conducting research.

One of the major incentives to purchase new seed is that a new variety comes with many possible benefits for the farmer (Tripp 2003). The strong growth of processing has created new demands for appropriate varieties (Tesfaye et al. 2011). The lack of effective seed systems holds back the rapid and wide-scale adoption of new varieties, with pro-poor traits, such as resistance to late blight, which would be particularly beneficial for smaller farmers who cannot afford expensive fungicides.

Farmers receive inadequate information about the benefits of using quality seed and of new varieties, inhibiting their broader uptake. Further hindering the uptake of quality seed by

[1] There are many different nomenclatures for describing seed. Here we use a term adapted to the 3G system, where the number of field generations is shortened, so that certified seed is reached in fewer field multiplications.

smallholders is lack of awareness and riskiness of investment (e.g., seed only available in standard 50-kg bags, need for complementary investment in fertilizer). Marketing strategies will be critical to educate farmers about the advantages and benefits of using high-quality seed and to further increase demand.

Unintentional dependency on donor interventions is a chronic risk as well. In a current seed potato project in Ethiopia, CIP (2011) found that farmers in one project area sold their entire produce immediately after harvest as ware potatoes and did not keep any for seed for the coming season. This was due partly to "farmers' expectation that next year's seed would surely be provided by other support agencies and that there was no need to keep seed for themselves" (p. 5). Dialogue to reach consensus across all donor agencies will be needed to ensure that seed is provided at a realistic price, as subsidies work against the emergence of a properly functioning quality seed market.

2.2.2 Seed use

Farmers may lack the knowledge or access to complementary inputs such as fertilizer to obtain the highest return on their quality seed. Farmers are risk averse, and the fear of drought may inhibit their investment; crop insurance is rarely available to mitigate this risk.

As noted above, certified seed requires a higher cash outlay. Farmers at distant locations who would incur higher transport costs will not be able to economically access this seed and production of certified seed is insufficient to meet current demand. A baseline survey conducted for the 3G and CFC projects indicates that about 60% of the farmers in Uganda and Kenya source their seed potatoes from untrained farmers, traders, and the open market (when they do go off-farm for their seed), believing this seed is of better quality than their own stock.

Seed degeneration is primarily caused by several tuber-borne pathogens, the most important being viruses and bacterial wilt. A number of relatively simple management activities can be done by farmers to reduce degeneration; however, untrained farmers are unaware of these practices. Many farmers use their own saved seed, normally by selecting small tubers from the ware harvest. Farmer management of saved seed can be substantially improved using PS to select healthier seed (see Box 2). Baseline studies in the 3G project showed that about 2% of potato farmers practice PS.

BOX 2. POSITIVE SELECTION

WITH POSITIVE SELECTION (PS), farmers select and mark healthy-looking plants as mother plants to produce better quality seed potato. Trials in Kenya under the 3G project showed yields to increase by 37% compared to farmers' seed.

PS involves:

- **Pegging** healthy-looking plants with stakes when the flowers first appear.
- **Checking** the health of the pegged plant two weeks later and removing pegs from any plants that show symptoms of disease.
- **Harvesting** the pegged plants one by one; plants with few or malformed tubers are not selected for seeds.
- **Storing** the selected tubers separately to be used as seeds.

Pegging healthy plants.

The bulkiness and perishability of seed potato require farmers to be highly knowledgeable of postharvest management practices when managing saved seed. Poor seed storage practices lead to low yields of the ensuing crop. Storing seed potatoes in diffuse light stores (DLS) produces quality seed that has several green, short, and sturdy sprouts leading to higher yields (Box 3).

BOX 3. DIFFUSED LIGHT STORES FOR SEED POTATOES

ALTHOUGH DLS WAS DEVELOPED BY CIP a couple of decades ago, it continues to be an important technique in several projects that are underway in both the SSA and some of the Roadmap countries.

ADVANTAGES

- DLS allows easy inspection of seed by farmers for them to regularly remove rotted, bruised, and dried potatoes before they become a source of infection, thus reducing losses
- Stronger more even sprouts
- Increased sprout number and longer storage period of up to six months
- Seeds have better emergence, more uniform growth, and better plant establishment, resulting in higher tuber yield.

PRINCIPLES FOR CONSTRUCTION

- Use locally available and cheap materials
- Structure with uniform light distribution for good seed tuber sprouting
- Build individual store 5 x 3 x 2.8 m, oriented east to west
- Locate first shelf should be 50–60 cm from the floor
- Make shelves 75–100 cm wide and place 50–60 cm apart
- Attach aphid-proof net along the wall.

DLS used by farmers in Eastern Africa lowered storage loss by 10–40%, reduced the time of crop emergence by about 10 days, and increased yields by 10–25%.

2.2.3 Value chain coordination

A strong and well-coordinated seed potato value chain with good information flows, strong service provision, and a linked ware market with more stable contractual arrangements is a prerequisite to the production of high-quality seed. But the coordination of value chains is susceptible to a number of bottlenecks:

- Most ware potatoes are transacted on spot markets and potatoes are highly perishable, hence periodic market gluts occur due to overplanting, extremely favorable weather, or both. The removal of constraints to crop productivity, including greater use of quality seed, without a defined market outlet, can also lead to temporary gluts. Gluts lead to a reduction in ware price and a knock-on effect to reduced seed sales. Commercial seed producers may not be able to absorb poor seed sales and could eventually turn to other businesses, which could compromise the sustainability of the seed potato value chain.
- A lack of trust and communication exists between seed potato value chain actors. Few opportunities exist for the different actors to come together to analyze shared constraints and innovate.
- Awareness and knowledge of seed technologies and business strategies are not always shared among value chain actors. Key actors in both the public and private sectors lack information-sharing platforms that would promote national and inter-regional dialogue, increase access to new technologies, stimulate collaboration, and promote joint innovation and investment.

2.2.4 Service provision for improving the seed potato value chain

Basic and certified seed is normally inspected by a mandated government agency following national seed regulations. At present, however, the disease tolerance levels in the Kenyan seed potato are based on those found suitable for seed potato programs in northern countries. Realistic quality standards need to be developed that reflect demand from ware potato farmers, the disease levels prevailing in farmers fields, and economic thresholds for disease incidence. This will require collaboration amongst pathologists, agronomists, and economists to establish realistic disease tolerance levels for seed potatoes for different types of potato farmers under local conditions.

Moreover, as the 3G project revealed, limited capacity of the inspection authorities delayed inspection, testing, and delivery. This highlights the importance of streamlining the testing and certification process. One option is to involve accredited private sector inspection. Another option is community-based quality schemes to address this bottleneck. Appropriate quality schemes, on national or local level, such as the new CIP/FAO QDS schemes, are creating opportunities for developing a private seed multiplication sector, including farmer associations. These schemes involve self-certification or certification through community-based organizations and others with rigorous yet achievable standards. These standards have to be compatible with national seed regulations using, for example, basic seed of registered varieties and registering producers.

Streamlined and harmonized variety testing, review, and registration procedures can likewise contribute to more efficient development of seed systems. The participation of private seed companies, public institutions releasing new varieties, and farmers in the regulatory regime are further key components to developing effective and responsive seed systems. The lack of source seed of appropriate new varieties with market demand to feed into the seed value chain is a significant bottleneck. Inadequate knowledge of farmers' demands for new varieties is a related weakness.

Absence of uniform sanitary and phytosanitary requirements, and necessary incentives and capacity to apply them, can result in trade of poor quality seed. There is need to implement a harmonized sanitary and phytosanitary system and facilitate access by African countries to information on plant health and quarantine measures and related issues, and develop low-cost technologies and human capacity to apply uniform plant health standards.

2.2.5 Policy

High-grade certification regulations adopted from developed countries are theoretically in place in most of the Roadmap countries; however, they are implemented only in Kenya and might not be completely appropriate to the conditions found in other areas in eastern Africa, where even with increased investment in the short and medium term the majority of farmers will not be able to access certified seed. These regulations only consider the high-grade (certified) production scheme, which in eastern Africa currently reflects less than 1% of the seed potato used by farmers. Current policy in several countries—Tanzania is an exception—does not allow QDS (discussed above) as an option to improve seed quality.

Quarantine risks may ensue from increased seed sector activity if regulatory capacities are insufficient. The movement of seed among fields, farms, countries, and regions can eventually increase disease spread. Although several tuber-borne diseases are not yet present in the Roadmap countries, introduction of any of these could be accelerated via seed, if the disease were undetected.

Without substantial levels of public and private investment and more support from policy makers for potato, agriculture policies and resources will continue to favor export cash crops.

3. CORE INVESTMENT AREAS

This chapter describes the principal activities of the five mutually reinforcing core IAs that are proposed to put the seed potato value chain interventions into practice (Fig. 3).

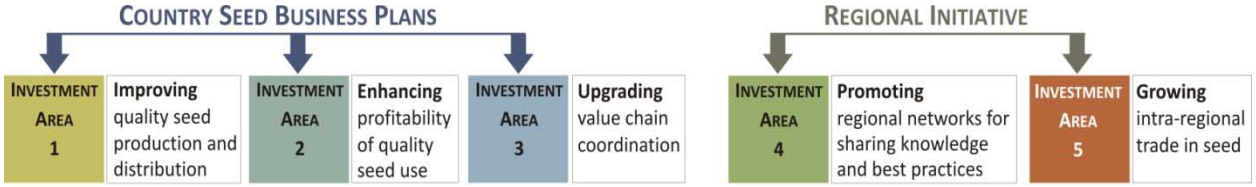


Figure 3 The Roadmap strategy is built around five mutually reinforcing core investment areas.

Three IAs make up country business plans, to be implemented by a group of national partners and managed and backstopped by CIP, with adaptations according to context in each of the five countries:

1. Improving quality seed production and distribution
2. Enhancing profitability of quality seed use
3. Upgrading value chain coordination.

The value of investment in each of the countries will be maximized by establishing a regional initiative guided by CIP to ensure spillover and learning across the Roadmap countries, build cross-country partnerships, and capitalize market opportunities for seed trade within the region. Hence two IAs are regional and potentially cross-cut all five countries:

4. Promoting regional networks for sharing knowledge and best practices
5. Growing intra-regional trade in seed.

The country business plans and the regional initiative should consider the investment climate in each of the countries—presented in section 3.4 and Table 3.2 of this chapter.

3.1 Country Seed Business Plans

IA 1: Improving quality seed production and distribution

Develop plans for sustainable seed business development

The starting point for IA 1 is an in-depth description of the actors—existing and potential—in the quality seed value chain and their seed production technology in each country. This will be followed by an analysis of the profitability of different seed enterprises and a strengths, weaknesses, opportunities, and threats (SWOT) analysis of the quality seed potato value chain building on the description of the investment climate (Table 3.2). The analysis will be carried out with the actors themselves, particularly those in the private sector, and will consider both minituber production and onward specialized multiplication.

The country business plans will build on the strengths and opportunities described in the SWOT. They will validate the targets for production of different seed categories along the value chain, analyze the existing capacity of seed businesses, and provide estimates of the capacity that would be needed to reach these targets. They should identify the types and size of investment that would be needed to close the gap, drawing on the lessons learned in the 3G project.

Improve infrastructure and capacity for quality seed production from in-vitro to G3

Improving infrastructure and capacity for high-grade seed production is resource- and knowledge-intensive. It requires investments in infrastructure, technical inputs, and other factors. The initial investment in constructing new RMTs and other types of infrastructure is risky because of the uncertainty about market size and farmers' lack of knowledge about RMTs. Part of this investment cost should be covered to create an incentive for entrepreneurs to enter or expand this activity.

In addition to strengthening existing TC labs already engaged in in-vitro production (public and private), new private TC facilities should be identified, to reach indicated targets for the respective countries. Here, entrepreneurs should be identified who can customize the TC technology for small and medium enterprises (SMEs) to suit local conditions without compromising product quality.

Turning next to RMTs, during the 3G project, there was notable involvement by the private sector in Kenya. In the other Roadmap countries, a significant increase is needed in minituber production capacity through RMTs. However, to reach the 5% or 10% targets for G4 seed described below, all countries, including Kenya, will need considerable investments in minituber production systems. This will mean involving selected private companies to respond to the unmet demand for G3 seed potato by providing technical backstopping in production and development of business plans for most appropriate and cost-effective RMTs (e.g., aeroponics, rooted stem cuttings, improved conventional systems) and field multiplication.

A yield of 20–25 minitubers/plant is needed to recover costs of the aeroponics system (Labarta and Mulwa 2011). The system is sensitive to high temperatures, so the choice of the location and season is therefore crucial, as high temperature at lower altitudes compromises production, and may make it unprofitable.

To expand G2 and G3 seed production it will be necessary to identify suitable locations and operators for specialized field multiplication in suitable areas (low aphid pressure and free of bacterial wilt) with enough land to conduct a proper rotation scheme. SMEs, with support of respective national programs, are likely the best ones to implement this type of seed production. This should be done by trained private seed potato producers with a backup production by the respective public sector institute. The diversity of farm entrepreneurs in the Roadmap countries will lead to different approaches. For example, in Kenya and Tanzania large cereal farm operations in the highlands are already engaged in seed production, considering it as an additional business and good rotation for cereals. In Ethiopia, Rwanda, and Uganda, the focus will be to form or strengthen existing specialized seed multiplier groups and/or associations by providing them with technical backstopping and training in business management to create a sustainable business opportunity as seed producer organizations.

Table 3.1 presents an estimate of the additional capacity needed in each of the Roadmap countries to reach levels of 5% and 10% coverage with G4 seed.

Table 3.1 Additional Production Needed in Seed Value Chain to Reach 5% and 10%, with G4 Seed, and Number of Farmers to be Trained in Seed Maintenance to Reach 5% and 10% Coverage

Country	G4 Seed Farmers Trained (%)	In-vitro Plants for RMTs ('000s)	New RMT Units	New Field Multiplication to G3 (ha)	Decentralized G4 Multipliers Trained	Farmers Trained on Farm Seed Maintenance ('000s)
Ethiopia	5	68	7	102	347	20
	10	137	17	216	893	41
Kenya	5	53	0	0	272	16
	10	105	6	72	693	32
Rwanda	5	54	4	70	285	16
	10	109	11	162	720	33
Tanzania	5	44	6	75	355	13
	10	89	12	149	710	27
Uganda	5	28	3	42	125	11
	10	56	7	89	350	22
Total	**5**	**248**	**19**	**272**	**1,383**	**77**
	10	**496**	**52**	**689**	**3,367**	**154**

Assumptions: each RMT unit is made up of 5*15 m = 120,000 MTs, average 2 ha potato multiplication for G4 production, average potato production 0.4 ha/year ware growers.

Improve seed distribution

A network of decentralized seed producers will need to be established in order to make seed available locally. This network needs strong linkages and coordination with the specialized seed producers (G2 and G3) to source their seed where the logistics of seed movement will be facilitated—for instance, by the district extension offices and/or traders.

Agro-input dealers must also be involved in seed potato trade, which is currently not the case. However, potatoes are bulky and improved storage facilities may be required. Nevertheless, innovative solutions like use of smaller seed bags and having larger agro-input companies, which regularly supply their network of smaller local agro-input dealers, distribute seed could be feasible.

Different innovative seed and variety diffusion strategies should be explored to diffuse clean seed to small private multipliers and ware potato growers. Possibilities include voucher schemes, seed banks (based on commodity loan systems), seed fairs, input loans (e.g., in Kenya, Equity Bank and Kenyan Women Finance Trust), and input insurance systems (e.g., Kilimo Salama by the Syngenta Foundation for Sustainable Agriculture). Another promising approach is one developed by Catholic Relief Services, who distributed subsidized vouchers that were redeemable for a preset period for a fixed amount of seed from local seed multipliers (Remington et al. 2002). This arrangement empowers the ware grower over choice of seed multiplier, timing of collecting seed, and choice of variety. The arrangement also allows growers to become aware of available seed multipliers in their locality and catalogues of seed suppliers to be produced as the scheme enlarges. In Kenya and Ethiopia, however, experience suggests that potato is a significant cash crop for smallholders and that subsidized voucher schemes may not be necessary to ensure uptake of quality seed.

Further important activities will establish linkages to existing informal seed distribution channels currently selling seed potato of unknown sources and qualities to the formal system. Those traders should be identified and linked to trained local multipliers.

A contract farming approach could help farmers access high-value markets linked to seed (and other input) provision by the processor on a loan basis to ensure a regular supply of the desired processing characteristics (e.g., the right variety, potatoes of appropriate age and qualities). This approach has already proved effective in the CFC-funded potato project.

Seed should be marketed, partly through awareness and demand creation campaigns, as described below, and through direct marketing such as the setting up of simple seed directories that list trained seed suppliers in a given district or neighboring districts.

Develop capacity of decentralized seed producers with a focus on empowering women

Producing quality seed requires a range of skills at various levels, from planning and management of seed production through skilled farm operations. Technical support for seed production is essential during early stages of development of seed enterprises. Improving entrepreneurs and farmers' skills and knowledge in seed storage, seed quality management, and accessing new varieties could do much to enhance uptake and spread of new varieties and improved practices. Seed production should be viewed as a business rather than a technical or development activity if it is to succeed, highlighting the need for business and entrepreneurial skills from the outset, and not just technical skills.

Private seed potato producers (individuals, groups, associations) should be identified and trained for decentralized multiplication using G3 seed. As implemented in the 3G project in Kenya, training of small private seed multipliers starts through identification of suitable candidates, profiled as having a minimum of 4 ha of suitable land or having the capacity to rent land (for rotation purposes), and identified by local extension services as being leading or entrepreneurial growers. It is especially important to empower female farmers as seed producers, as they are predominately engaged in potato production in eastern Africa, and experiences from previous projects have shown that women are excellent multipliers (USAID 2010). The number trained should be rationed according to the number of growers per district so that a decentralized network of seed multipliers can be established across all districts and thus reduce the distance travelled for potential seed purchasers.

The activities to ensure a sustainable onward decentralized seed multiplication could involve the identification and massive training and backstopping of at least 1,400 "secondary" seed producers, linked to specialized seed producers by, for example, contracted out-grower schemes and development of marketing and business plans.

Similarly, training of field multipliers within the seed production chain would lower costs and thereby increase profitability. Improved capacity to multiply seed by commercial multipliers would also improve sustainability of the enterprise by reducing the risk of seed loss (or rejection) due to the influx of pests and diseases.

Improve capacity for seed quality control

It will be necessary to complement efforts to increase the capacity of national programs and plant health inspector services to enable them to monitor and backstop seed production through:

- Advocacy and piloting of farmer/community-based quality standards, practicing self-certification and labeling (QDS), with limited regulatory oversight
- Training of community-based or grower association-based inspectors to support QDS
- Improved and easy-to-use low-cost disease detection methods.

Improve technology for seed multiplication

To strengthen the seed potato value chain, a continuous functional research support system for the seed sector is important in several respects. The improvement of in-vitro and minituber production will provide more efficient methods and reduce risk. Research on field multiplication at the farm level would concentrate on best agronomic measures like improvements in plant nutrition and disease control. Furthermore, research has to be conducted on development and shifts in the occurrence and severity of the major seed-borne diseases. In some regions, climate change effects will increase disease and pest pressure on potato production. Late blight and bacterial wilt are expected to expand into areas that have previously been fairly disease free; aphid populations are likely to increase in certain regions, in different seasons, and move to higher altitudes with more favorable climatic conditions.

Research organizations can contribute to development of minituber production by investigating new technologies for multiplication, well suited to the conditions in the respective countries/regions (e.g., by fine-tuning aeroponics to specific varieties, and managing disease in aeroponics systems).

Ongoing degeneration trials will help determine the number of acceptable generations in the field. Decentralized multipliers can be supported by testing alternative quality control systems, standards, and easy, low-cost disease detection techniques and effective approaches such as the branding of quality seed. This could be combined with testing options for on-farm seed maintenance.

Increase demand for improved seed and market-preferred varieties

The 3G project successfully increased awareness of the advantages of high-quality seed through several mechanisms that should be further developed (Box 4). This includes planting demonstration plots comparing quality seed with farmer-saved seed, distribution and/or sale of quality seed to farmers in small quantities (5–25 kg), and the use of different media channels. Because specific strategies to be used depend on the local context, seed entrepreneurs must stay abreast of market-preferred varieties and have the resources and knowledge needed to produce high-quality seed of those varieties. Communication and feedback mechanisms (e.g., innovative voucher systems) need to be developed and maintained to ensure that relevant value chain actors are aware of what the market is responding to and its needs.

Through demonstration plots, farmers will be shown and feedback gathered on new potato varieties with value-added traits (e.g., disease resistance, shorter growing season, or heat or drought tolerance) that could enter the quality seed system. For example, farmers in Ethiopia have not had access to new, late blight-resistant varieties because the formal seed system produces only a

BOX 4. IMPROVED SEED ACCESSIBILITY: TESTIMONIALS FROM SECONDARY SEED MULTIPLIERS, JUNE 2011

"THIS IS THE first time I planted large amount of seed potatoes. I ordered 16 bags of Tigoni variety from Kisima farm through the DAO's office and I'm happy because the crop is looking good with 100% emergence and good uniformity. Many ware potato farmers have already booked the seed."

Mr. Ishmael Kiptoo, seed multiplier, Keiyo North district

"IN MARCH 2010, we managed to buy G3 seed enough for 4 acres. This is the largest acreage we have ever planted [*field crop shown here*] after we started seed potato enterprise. We are planning to register for certification."

Mrs. Sophia Wamboi, Chairlady, Gatimu FADC Seed multiplier group, Limuru district

"I'M NOW ABLE to get constant supply of quality starter seed (G3 seed) and I'm happy that I can provide my fellow potato farmers with quality seed within their reach every season."

Mr. Amon Mgendi, seed multiplier, Taita district

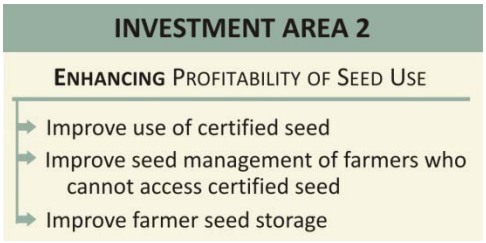
tiny fraction of the seed planted. Other traits of value include virus and drought resistance, variation in maturation and dormancy periods (for more flexible planning), improved nutritional characteristics, and greater yield stability. These, combined with desirable processing qualities, reflect the needs of a fast-growing potato-processing industry and expanding urban market in eastern Africa. The registration and cleaning of farmer- and market-preferred unregistered, introduced varieties (e.g., escapes from the variety testing and release process) should be supported to increase the range of varieties available through the regulated seed system. These activities will generate increased demand for seed as market-demanded new varieties enter the quality seed system.

The development of sustainable strategies for managing and delivering source seed—including contracting for sale of breeders' seed—by national agricultural research systems (NARS) can stimulate commercial seed production and farmer-to-farmer diffusion of new improved varieties and additional benefits to farmers. Meanwhile, communication to develop demand for new varieties, combined with strengthening local seed systems, can stimulate the exchange of seed by farmers and the emergence of formal seed enterprises.

IA 2. Enhancing profitability of seed use

Improve use of certified seed

Productive, profitable seed system performance relies on the skills and capacities of farmers to benefit from high-quality seed. A commercial seed sector can only grow in response to the demands of a skilled and discriminating farming population (Tripp 2003).



Farmer training will help farmers get the best out of their clean seed. For example, if farmers understand that virus diseases are transmitted by aphids, and that aphids acquire virus from other sources, they can readily see the value of removing virus-infected *solanum* weeds from hedge rows. Farmers can also avoid planting clean seed in soil infested with bacterial wilt if they understand the contamination routes of this disease. Linkages will be established with initiatives (including a parallel program supported by the International Fertilizer Development Corporation, or IFDC) to promote access to and better use of fertilizer, as clean seed is highly responsive to increased input use.

Throughout IA 2, new ways of extension should be piloted (e.g., farmer-to-farmer, private local extension services, and contract farming with extension components).

Improve seed management of farmers who cannot access certified seed

Existing farmer-training networks need to be strengthened in order to enhance farmers' capacity to extend the quality of their seed. Training materials are already available that help facilitators train farmers to maintain seed quality through practices such as PS, on-farm sanitation, rotation, and proper seed storage. However, for farmers to effectively perform PS they need to understand that degeneration is associated with diseases symptoms, and they need to accurately identify diseases in the field to effectively select the disease-free plants. Farmers must learn to protect their investment in seed by slowing down degeneration and thus reaping additional benefits over several years from the high-quality seed they have purchased.

The aim is to implement massive training of at least 30,000 farmers in on-farm seed maintenance and on-farm saved-seed quality improvement.

Improve farmer seed storage

Appropriate seed storage is an important component of profitability. Poorly stored seed will produce lower yields and lead to more pest and disease problems.

As discussed above (p. 10, Box 3), DLS can be built by farmers themselves from locally available materials, with technical backstopping by researchers or extension people. As the seed potato value chain matures and the adoption of DLS expands, trained small private seed multipliers or community-based seed multipliers should also be involved in DLS construction.

Seed storage warehouses also help solve a major problem for farmers—namely, not having enough reliable, healthy seed available when it is most needed for planting. When professionally designed and built to store high-quality seed, these facilities could meet the sanitary and phytosanitary conditions and requirements needed to add value to certified and QDS planting material. Farmer-owned seed coops are another way to increase seed storage capacity, promote trust among seed value chain actors, and provide a good "incubator" for learning essential business management skills on a small scale.

IA 3: Upgrading Value Chain Coordination

Improve trust and communication and stimulate joint innovation

Innovation in value chains is frequently short-circuited by a lack of trust and communication between actors. To develop a viable seed potato value chain, linkages between service providers, basic-seed producers, decentralized seed multipliers, and ware producers need to be improved. A possible starting point is the application of the Participatory Market Chain Approach (PMCA), developed by CIP and already applied to over 10 value chains (Devaux et al. 2009; Horton et al. 2009). PMCA brings together small farmers, market actors, and service providers for an intense process of facilitated interaction. The PMCA approach uses a flexible, three-stage participatory process over 9–18 months to improve communication, build trust, and facilitate collaboration among participants so that they can jointly identify, analyze, and exploit new market opportunities. This approach builds trust among seed potato value chain actors, enhances communication, and promotes joint innovation around new market opportunities in the value chain (Bernet et al. 2007). PMCA will require investment in training process facilitators and organizing thematic group meetings around new business opportunities (e.g., decentralized seed production and seed distribution by agro-input dealers) to build product concepts and gauge market potential). It also will stimulate joint innovation required to meet the quality parameters associated with each market opportunity.

Create platforms of seed potato actors

Farmers should have access to enough information and training so that seed multiplication and business development create a profitable alternative for those located in appropriate environments (Tripp 2001). Flow of information is exceptionally important for the agricultural sector, and seed provision is particularly dependent on the availability of timely information.

To overcome the lack of information flow about seed business, seed potato stakeholder platforms should be formed with appropriate linkages to the wider potato value chain at each location. For example, the recently founded National Potato Council of Kenya shows how the private sector—from seed producers, farmers organizations, processors, NARS, and the Ministry of Agriculture—engages in active communication and develops strong linkages in the whole potato sector. Functional platforms will facilitate the flow of technical and market-related information for the seed business.

Major gaps in the information pipeline and stakeholder decision support concern (1) demand versus supply of quality seed, (2) guarantee and traceability of seed quality, and (3) new trends in terms of varieties and production technologies. Principles of agile and user-friendly information systems can be better exploited for the benefit of seed businesses.

A virtual market place for seed tuber supply and demand should be created with information about sources (companies), volumes, conditions, and the like. Market information can be connected to social media and mobile networks to keep subscribers updated.

For example, having a seed directory with information about seed availability (where, how much of which variety, and when) and variety descriptions for each country would facilitate business. This seed directory would be made available to extension officers, farmers, and seed traders via SMS mobile phone information system and the Internet. A database of growers and farms involved could be built and maintained to monitor progress; dynamic maps of seed production regions could be produced through the use of GIS tools. Moreover, the platforms provide stakeholders with relevant information about such topics as agronomy, postharvest physiology and management, market development, and credit sources.

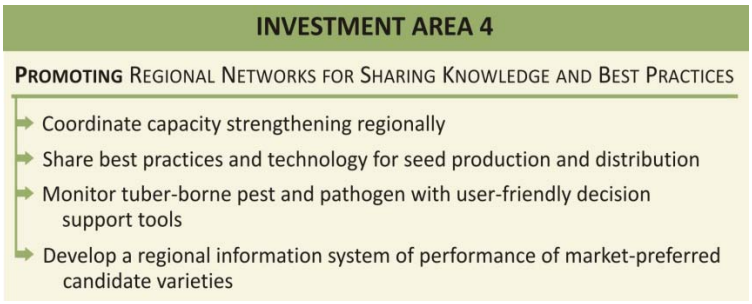
Once stakeholders agree to form platforms to pursue seed-related business opportunities, they are strengthened to interact with business development service providers that can help them access services like finance (credit) and complementary inputs, among others.

3.2 Regional Initiative

IA 4: Promoting regional networks for sharing knowledge and best practices

Coordinate capacity strengthening regionally

Major gaps in seed sector capacity building include (1) technological innovation (production, storage, variety portfolios) and (2) business management (marketing, labelling, positioning). Skills, knowledge, and replicable knowledge do exist in the region but need to be scaled up so that widespread benefits and economies of scale can be achieved for Africa´s emerging seed potato sector.



Underscoring virtually every activity proposed in the Roadmap and its potential for success is the pivotal role of building capacity through training and information sharing (see Box 5). Capacity building with key partners in each country should be targeted to take adequate stock of how many value chain actors—from aeroponics production to farmer seed maintenance—can be reached at the lowest possible transaction cost. Specialized capacity-building modules, incorporating new curricula and learning tools, need to be developed for trainers, producers, and businesses in the region. CIP recommends four candidate capacity-building modules that have proved effective in other seed potato projects.

- "**Seed-entrepreneurs' business schools**," drawing on "farmer business schools" that CIP has successfully applied in Asia, can be used to train decentralized seed multipliers as a key group of actors. The regional implementation of the training of trainers for seed-entrepreneurs' business schools will ensure consistency in content and methodology, and be more cost effective.

- **Cross-country visits** help promote and foster successful seed production operations at different points along the value chain concerned with multiplication (in vitro, minituber, field multiplication).
- **Short training events** (two to five days), organized regionally on specific technical or methodological topics, should be provided by subject matter specialists. Examples of seed topics are included in a recent publication funded by the Bill & Melinda Gates Foundation[2] and include concepts of quality, planning, production plans, and technical aspects of seed production and storage. Some of the courses could be organized in coordination with the Seed Enterprise Management Institute, under the Programme for Africa's Seed Systems of AGRA, hosted at the University of Nairobi. Additional topics, specific to vegetatively propagated crops, could be included in the formal courses, such as the application of the concept of QDS[3] to vegetatively propagated crops.
- **On-the-job training** can be provided by specialists to emerging seed businesses through technical and methodological backstopping. Once key stakeholders have been introduced to basic concepts of the potato-seed business and some have agreed to a formal partnership arrangement, specific actions should be taken to strengthen certain capabilities according to local contexts.

BOX 5. TESTIMONIALS FROM 3G PROJECT BENEFICIARIES

STRENGTHENED CAPACITY ENHANCES POTATO PRODUCTIVITY

"In our demo plots, we harvested over 25 t/ha of potatoes using PS seed. This convinced me that with a field of 1 ha under potatoes, a farmer could live better than a full-time employee. With the knowledge learnt from PS, potato is becoming my life in the future."

MUKAYUHI Capitolline, Kivuye sector, ***Rwanda.***

"The 3G project has changed potato farming in Transmara district. We have recorded a steady increase from 2008, courtesy of project interventions. The trained farmers, particularly the seed multipliers are doing potato production as a business unlike before when it was considered a 'kitchen garden crop'."

Mr. Earnest Muendo, DAO, Transmara district, ***Kenya****.*

"The project has improved household food security. Trained farmers are now able to produce potatoes that can feed their families for some time. Before the project started, the district was entirely dependent on potatoes from neighboring districts. At least 10% of the potatoes sold in the district are now produced within the district."

Mrs. Charity Kiritu, DAO, Igembe South District, ***Kenya****.*

Share best practices and technology for seed production and distribution

Sharing best practices and technology for seed production and distribution among different eastern Africa countries will be essential to ensure progress towards sustainable seed systems. This exchange will facilitate information access and knowledge building on previous experiences, avoiding making similar mistakes, improving efficiencies, and using best practices whenever appropriate. Communities of practices can be organized on key topics within countries and across countries (e.g., on aeroponics and farmer seed maintenance). These will link the country level platforms and other activities.

[2] O'Connor, A. (Ed.). 2009. The African Seed Company Toolbox: 52 Tools Every Seed Company Manager Should Know How to Use. Bill and Melinda Gates Foundation.

[3] FAO. 2009. Quality declared planting material: protocols and standards for vegetatively propagated crops. FAO Plant Production and Protection Paper 195. FAO, CIP. Rome.

Monitor tuber-borne pest and pathogen with user-friendly decision support tools

In other regions of the world, information on disease and pest pressure allows public and private institutions to identify "seed potato production zones"—for example, in Chile, Argentina, and India. There, "clean" geographical areas are supported with investment and (regional) regulation to set up specialized spaces for seed production accompanied by certification and labelling schemes that recognize denomination of origin. A survey should be conducted to evaluate the status of seed-based pests and diseases as a precondition for the safe movement of seed, leading to the identification of "clean" areas suitable for seed production and monitoring systems.

Ensuring the phytosanitary status of seed is an important component of seed production and will be crucial for regional exchange of seed. To date, no such common database exists and, in fact, very few studies have been done on tuber-borne diseases in the region. Thus, while seed systems aim at managing tuber-borne diseases, the full extent of such diseases in the region is not known. To this end, a regional database of tuber-borne pests and pathogens of potato should be built in order to provide decision support tools to policy makers involved in quarantine-related issues.

To manage quarantine risks, public and private sector partners should commit to improving the knowledge base on plant health and develop functioning integrated quality assurance systems for the seed potato sector in eastern Africa. Research on plant health; promotion of appropriate technologies, best practices, capacities, and policies for avoidance and detection; communication; and institution strengthening constitute an integrated strategy to prevent the spread and introduction of plant pests and pathogens.

Cross-border trade, however, will require very stringent quality assurance and norms must be standardized across the region. These norms will be based on sound scientific knowledge of the risks of quarantine pests and diseases currently not present in the region or limited to specific locations.

Develop a regional information system of performance of market-preferred candidate varieties

Considerable investment is required to develop ware and processing varieties that are market preferred, disease and pest resistant, high yielding, and climate hardy, but information about (and access to) these innovations is not evenly distributed. When done at all, data sharing has often been ad hoc rather than as part of systematic approach. User-friendly consultation tools should be developed for (1) varietal performance data for researchers and (2) varieties ready for deployment with high market potential for seed businesses.

IA 5: Growing intra-regional trade in seed

Conduct market opportunity studies for regional trade in seed potato

Market opportunity and relative cost of productions studies need to be conducted to identify possibilities for expanded trade in high-quality seed potato within the region, building on studies in Kenya (Labarta and Mulwa 2011). The studies should look at (1) relative costs of production and favorable conditions (e.g., low virus vector pressure, sufficient land for multiplication, and capacities for seed production across the countries where trade could occur) and (2) transport and transaction costs to identify market niches in the Roadmap countries that could be served by a lower cost and more efficient producer of clean seed in another country.

Trade of quality seed can be of comparative advantage for potato farmers in the region (e.g., seed can be produced cheaper in other countries) and, as in Rwanda, land for multiplication is limited. These two factors can make quality seed more affordable for farmers and create lucrative business opportunities for seed producers in the region.

The creation of reliable access to larger, more predictable markets will create incentives for investments in more efficient seed production and seed trade, which eventually increases supply and choice of quality seed to farmers at a reasonable price. Furthermore, investments in regionally managed alliances of public and private partners can help open up those markets. This has already happened with maize following seed sector liberalization in Kenya. Many vibrant private seed companies compete to make improved varieties available to farmers, and Uganda's seed sector is developing rapidly. Bringing these benefits to smaller countries like Rwanda can be accelerated by focused partnerships to encourage private investments.

Harmonize regulations for cross-border trade, seed quality, and quarantine

The harmonization of phytosanitary standards is a prerequisite for cross-border trade. The goal of harmonized standards is to facilitate movement and fair trade and to eliminate technical barriers to trade in seed potato planting materials. This initiative would improve producers' profitability and encourage production of high-quality seeds and planting materials and protect consumers' interest. To achieve this goal, the standard should address requirements and certification for varietal identity and purity, genealogy and traceability, diseases and pests, external quality and physiology, and sizing and labeling.

Recently, a draft for the harmonization of seed quality standard for the East African Community (EAC) was developed with support from the Policy Analysis and Advocacy Programme of ASARECA and through a USAID grant. The process of formulation and mobilization of stakeholders to review the standard in national and regional fora is ongoing. Beyond supporting this harmonization of EAC seed potato standards, a Roadmap project should engage actively in plans for policy dialogue and advocacy beyond the EAC member states, to address policy and regulatory issues that affect the distribution and sale of planting material for potatoes and other vegetatively propagated crops to improve domestic and foreign investment by expanding markets beyond national borders.

The dialogue between scientists and policy makers is a crucial aspect for harmonization and regulatory change. The sharing of current relevant knowledge to inform policy is facilitated by documenting the gains to liberalized or harmonized trade, quantifying the economic costs and gains, and informing decision makers through policy briefs and engagement in policy dialogue. National seed services should be encouraged to share information about seed supply and demand, promoting and monitoring truth-in-labeling, and training to improve the quality of seed production.

Transfer, acquisition, and dissemination of seed are highly dependent on safe movement of planting materials and the need to avoid introduction or dissemination of devastating plant pests and diseases from one country to another. In eastern Africa this is governed by plant protection and quarantine regulations and procedures, which are not harmonized yet and consequently hinder cross-border movement of seed potatoes in the region. Therefore, efforts have to be taken in account to support, for instance, the existing ASARECA harmonization initiative.

3.3 Monitoring and Evaluation

Putting the Roadmap into operation would require a dedicated monitoring and evaluation (M&E) system. This should be done jointly with IFDC, AFSTA, and ACTESA and in early consultation with the funding agency, to develop a methodology for the M&E of interventions in seed potato value chains, focused on private sector initiatives in planting material for vegetatively propagated crops. The starting point is a country-level description of the value chain and the initial levels of production, with outputs and outcomes derived from the business plans to form the basis for the M&E matrix. Regional IAs will require an additional set of outputs and outcomes to be developed.

3.4 Investment Climate

The five Roadmap countries share a number of factors within their eastern Africa region to make it feasible to chart a five-year strategy to strengthen the seed potato sector. There are also significant differences within this grouping that will affect the target milestones and deliverables outlined in this document. Table 3.2 lists several major strengths and weaknesses specific to each country that may affect the business-enabling environments and potential gains from implementing the IAs advocated here.

Table 3.2 Business-Enabling Environment in the Five Roadmap Countries

Country	Factors That Can Influence the Investment Climate for Seed Potato Value Chain	
Ethiopia	***Strengths***	(1) Increased availability of quality seed priority in national Growth and Transformation Plan; (2) Seed standards available for potato; (3) Dense national network of microcredit and saving institutions; (4) Good quality agricultural research institutions and universities; (5) GOs and NGOs active in seed production and distribution; (6) Decentralized, commercially oriented Farmer Seed Producer Groups
	Weaknesses	(1) No functional seed certification scheme; (2) Inefficient national banking system; (3) Landownership poorly defined, land not available as collateral; (4) Distribution of seeds of unknown health status; (5) Few commercial, large-scale seed enterprises; (6) GO over-regulates, hampering private sector investment; (7) Farmers lack access to timely price information
Kenya	***Strengths***	(1) Positive regional trade integration; (2) Biggest economy in East African Community; (3) Strong legal and regulatory framework on certification of seed potato; (4) Farmers willing to pay; (5) Several grassroots credit/banking institutions willing to invest in agriculture—some already involved in potato production; (6) Specialized national research program and universities, strong lab facilities; (7) Strong support by the GOs and NGOs in seed production and distribution; (8) Registered apex organization—National Potato Council of Kenya; (9) Many processing companies driving seed demand
	Weaknesses	(1) Inadequate personnel seed regulation; (2) Farmers' fear/unwillingness to apply for credit; (3) Limited funding of NARS; (4) Inadequate land for rotation owing to fragmentation; (5) Limited land free of disease; (6) Limited number of processing varieties; (7) Poor market infrastructure and services; (8) Poor dissemination of market information
Rwanda	***Strengths***	(1) Increased availability of quality seed is government priority; (2) Seed potato standards available; (3) Crop Intensification Program ensures durability of food security and regional trade integration; (4) Existing seed production value chain; (5) National and regional microcredit and savings institutions; (6) Active ARIs and NARS; (7) GOs actively involved in seed production and distribution
	Weaknesses	(1) Formal seed system dominated by the government; (2) Private sector in seed system is not strong enough to convince financial institutions to lend; (3) Limited involvement of NGOs in seed production and distribution; (4) Informal seed system dominates 99% of seed distribution (unknown health status); (5) Market price information is available from few main markets
Tanzania	***Strengths***	(1) Liberalized seed industry since 1990s; (2) Government potato program to enhance production; formal legislation on seed; (3) Micro-finance policy and national microfinance bank; (4) Potato a second priority in NARS; (5) Policies support value chain analysis and empower Tanzania Official Seed Certification Institute (TOSCI); (6) Agricultural seed agency in charge of production and trade; (7) The Southern Agricultural Growth Corridor, a PPP, links agricultural farming and services businesses, with interest in seed potato
	Weaknesses	(1) Limited implementation seed-related regulations; (2) No detailed strategies for potato sector or seed potato production; (3) Limited seed-related business accessing credit or micro-finances; (4) TOSCI has no recent experience or staff for potato-seed certification
Uganda	***Strengths***	(1) Market liberalization and privatization, strong drive to attract private and foreign investment; (2) Established potato R&D program; (3) Seed, ware, and processed products standards available; (4) Centenary Bank implements a special credit facility for small-scale farmers; (5) Potato is priority enterprise in NARS and for NGOs; (6) Developing specialized seed potato producer farmer groups
	Weaknesses	(1) Absence of potato subsector development plan; (2) Inadequate implementation of potato products standards; (3) Limited farmer knowledge of credit management; (4) Value addition research not prioritized; (5) Weak farmer-managed institutions; (6) Low farmer bargaining power

4. EXPECTED IMPACTS OF THE INVESTMENT

To achieve the targets presented in chapter 1 and Table 3.1, an investment of US $15 million is required over a five-year period across the five Roadmap countries. These investments will benefit different actors and productive enterprises along the seed potato value chain:

- Minituber production
- Specialized field multiplication (two field generations: G2 and G3)
- Secondary decentralized onward field multiplication (one field generation: G4–G5)
- Ware farmers using high-quality G3 seed in small quantities
- Ware farmers using high-quality G4/G5 seed
- Ware farmers using PS seed.

The $15 million investment is expected to facilitate the scaling up of the production of high-quality seed (G4), and a reasonable scenario is that it would cover at least 5% of the total annual requirement of potato seed of Rwanda, Uganda, Tanzania, and Ethiopia and at least 10% of the total annual requirement of potato seed in Kenya by the end of the five-year investment period. CIP calculated the production level for each group of actors involved so that this target can be met (see Annex A). On the basis of current evidence of seed potato production and use, profitability, and marketing (Labarta and Mulwa 2011), we estimated the expected potential profits of the $15 million investment for each actor and for the total investment (Table 4.1).

Table 4.1 Potential Annual Profit of Interventions in Seed Potato Production and Use of G4 Seed in the Roadmap Countries (in thousands of US $) in Year 5 of Intervention

Country	Minituber Production	Specialized Multiplication	Secondary Multiplication	Ware Production Using G4	Positive Selection: 93,000 Trained Farmers	Distribution of 3G Seed in Small Quantities (250 t)	Total Annual Potential Profit Increase
Ethiopia 5% G4	171	46	495	6,336	187	408	6,105
Kenya 10% G4	264	71	763	9,763	519	334	9,423
Rwanda 5% G4	145	39	419	5,033	268	334	5,071
Tanzania 5% G4	104	28	300	4,114	219	334	4,010
Uganda 5% G4	81	22	235	3,474	205	371	3,389
Total	**766**	**207**	**2,213**	**28,720**	**1,398**	**1,782**	**35,086**

By year five, all countries would be generating profits for each group of value chain actors (see Annex A for details on the calculation of potential financial benefits of each actor) and the level of benefits should stay the same even after the end of the intervention. Out of the $35 million expected to be generated annually by this intervention from year five onwards, 97% of these profits are expected to go to resource-poor farmers (around 240,000 households). Important levels of profits will also be generated for private sector investors involved in the production of minitubers and certified potato seed.

Although most of the benefits of this investment will be realized towards the end of a project intervention, there are many financial benefits that would start flowing from the beginning. Table 4.2 summarizes a net present value (NPV) and internal rate of return (IRR) analysis for the first 5 and 10 years of financial flows related to the 5-year investment. A 10-year period is taken because the benefits of investment will continue to flow even after the investment period itself has finished.

Table 4.2 Potential Annual Profits and Investments, NPV, and IRR of the Seed Potato Interventions in the Roadmap Countries (in thousands of US$) for 5- and 10-Year Horizons

Years	Annual Gross Benefits	Annual Cost/ Investment	Annual Net Benefit	Investment Profitability
1	230	3,000	-2,770	
2	959	3,000	-2,041	
3	10,954	3,000	7,954	
4	21,594	3,000	18,594	
5	35,086	3,000	32,086	
6	35,086		35,086	
7	35,086		35,086	
8	35,086		35,086	
9	35,086		35,086	
10	35,086		35,086	
NPV (10 years)				**$128,675**
IRR (10 years)				**156%**
NPV (5 years)				**$37,833**
IRR (5 years)				**142%**

Even with the conservative assumption in production and use of quality seed and the profitability level of each of the potato seed enterprises, we expect that the investment of $15 million will generate a total NPV of $128.7 million in the first 10 years and an IRR of 156%. Even considering only the period of investment of 5 years, this investment in the seed potato value chain is expected to generate an NPV of $37.8 million and an IRR of 142%.

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ANNEX A. ASSUMPTIONS FOR ESTIMATING THE IMPACT OF THE IMPLEMENTATION OF THE SEED POTATO ROADMAP IN FIVE COUNTRIES IN EASTERN AFRICA

The calculations of the expected impact if the investment areas outlined in the Roadmap were to be implemented as part of a seed potato value chain project in five African countries are based on evidence collected from specialized seed producers, secondary seed multipliers, adopters of positive selection, and ware potato producers in Kenya, Uganda, Rwanda, and Ethiopia (Labarta and Mulwa 2011, Obado 2011, Kaguongo 2009, CIP 2010). We have included data on productivity of different seed enterprises and the profitability of each of them per unit of land. For this exercise we have calculated the marginal benefit of the intervention, which consists of the difference between the profitability per hectare of a seed enterprise and the alternative or base enterprise that would be used in absence of the proposed implementation. In most cases, we have opted for conservative assumptions in terms of productivity and profitability. Other scenarios can be found in Labarta and Mulwa 2011, where a full description of the profitability of different potato seed enterprises is analyzed. Tables A.1 and A.2 summarize the key assumptions made in production and profitability of different potato seed enterprises of the seed potato value chain. Minituber production is not included in the tables, but the marginal benefit of 1 minituber is US $0.101.

Table A.1 Key Assumptions of the Calculations for the Economic Impact of Implementing Roadmap Strategies for the Seed Potato in Eastern Africa—Seed Production and Profitability

Indicators	Production of G3 Seed	Production of G4 Seed	Traditional Specialized Seed Production	Use of Seed from Ware Production
Type of seed used	G2 seed	G3 seed	G4/G5 seed	Farmer seed
Yields (t/ha)	25.0	18.6	17.5	10.9
Benefits (US$/ha)	2,910	1,612	2,037	864
Mg benefit (US$/ha)	873	748	0	0

Note: In the absence of current 3G seed production, the alternative is production of seed among traditional specialized seed producers. In the absence of current G4 production, the alternative is use of seed from ware production. These alternative scenarios are used to estimate the marginal benefit of the intervention for producing 3G and 4G seed, respectively.

Table A.2 Key Assumptions of the Calculations for the Economic Impact of Implementing Roadmap Strategies for the Seed Potato in Eastern Africa—Ware Potato Production and Profitability

Indicators	Use of G4 Seed for Ware Production	Use of G5 for Positive Ware Production (from small quantities of G3)	Use of Positive Selected Seed for Ware Production	Base Scenario for Ware Production
Type of seed used	Farmer seed	PS seed	G4 seed	Farmer seed
Yields (t/ha)	15.9	14.1	12.3	10.9
Benefits (US$/ha)	1,636	1,328	1,016	864
Mg benefit (US$/ha)	772	464	152	0

Note: For ware production, the alternative scenario is always the production of ware potato using farmers' own seed. The marginal benefits are calculated relatively to this scenario

ANNEX B. PARTNERSHIP PLAN

B.1 Partnerships and Actors

The partnership plan presented here is based on the scenario of CIP leading a wide range of partners to implement a five-year project in the five Roadmap countries. The plan as detailed here will be vetted by USAID for its comments and approval before any project agreements are finalized. CIP, a hub for potato germplasm and potato-related technologies, will work at the regional level with the different programs of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA), the Common Market for Eastern and Southern Africa (COMESA), the African Seed Trade Association (AFSTA), and Eastern Africa Seed Committee (EASCOM) to develop a favorable policy for seed potato and enhance its quality, strengthen seed potato associations at regional and national levels, and promote regional trade for seed potato and other potato products by avoiding tariff and non-tariff barriers. CIP will also work with the Alliance for Green Revolution in Africa (AGRA) to train breeders, seed specialists, and agronomists. Collaborations with regional programs such as the SSA-Challenge Program will enhance spill over to countries beyond the five proposed in the Roadmap. Partnering with the private companies that produce and distribute quality potato planting stocks will be given special attention. Collaboration with this network of partners, coupled with favorable regional trade, can help break the seed potato bottleneck in the entire region. It will lead to increased contribution of the potato subsector to achieving the 6% economic growth target set by the New Partnership for Africa's Development (NEPAD) by 2015 and the Millennium Development Goal.

At the national level, CIP will partner with key private sector actors and parastatals as basic drivers to commercialize the seed potato subsector, and with NARS of the respective countries to release improved potato varieties, produce nuclear seed, and build capacity. The Ministry of Agriculture (MoA) will lead dissemination of technologies, farmer training, and also play a seed quality regulatory function that will enhance regional seed and germplasm exchange. Partnering with selected universities in all or some of the countries will enhance training and capacity of researchers. Since the strength of the seed potato subsector will be affected by the entire potato value chain, a strategic partnership will also be forged with input and output traders, transporters, and processors.

The Kenya Plant Health Inspectorate Service (KEPHIS), an affiliate agency of the Kenya MoA, will support the seed companies in the region in seed potato certification and quality control, particularly for regional export trade. KEPHIS can be upgraded to serve as a center of excellence for regional quality control and help national programs develop their own quality control laboratories. CIP will partner with policy organizations and other stakeholders to develop seed potato quality standards that will reflect the reality for national and regional seed potato exchange. The concept of quality declared seed (QDS), developed by FAO and CIP, will be employed to enhance national seed exchange, where quality standards will be less stringent, to help promote production and utilization of quality seed.

B.2 Mapping Current and Potential Partners

There will be strategic partners related to regulatory function, technical and methodological backstopping (see Table B.1), who will include the MoAs of respective countries to help in seed policy issues, variety release, seed certification, dissemination of technologies and training; NARS to develop and promote technologies, produce breeders seed, conserve germplasm/varieties, conduct quality control and seed certification, enhance capacity building for researchers and other

stakeholders; and NGOs that will bring special skills to help in the dissemination of technologies. In addition to strategic partners, there will be primary partners, including those who will benefit from the improved potato seed business, such as selected farmers' associations, seed traders, transporters, microfinance organizations, universities, and decision makers in charge of development investments. There will also be a number of secondary partners who will benefit from the project but may not necessarily involve in the project directly unless otherwise deemed necessary in the course of project implementation.

Regionally, CIP will facilitate partnership with strategic partners (Table B.2), including ASARECA, AGRA, AFSTA, EASCOM, and ACTESA and (in that order of importance) to develop a favorable policy and regulatory environment for seed potato promotion; enhanced seed quality; local, national, and regional trade; and networking among others. With these partners, CIP will put in place a regional M&E mechanism to ensure that regional and national objectives are progressively achieved. We also envisage that partnering with organizations with experience in the promotion of seed of vegetatively propagated crops, such as Catholic Relief Services (CRS), an international NGO with a wide regional presence, will enable the project to strengthen the dissemination of quality seed potato of the improved varieties using their voucher approach (Walsh et al. nd) as a model. This approach proved to be successful in the dissemination of cassava and sweetpotato planting materials. To promote spill-over beyond the five Roadmap countries, CIP will facilitate partnership also with a primary partner, SSA-Challenge Program. Effective regional partnership coupled with a favorable policy, especially in the areas of regional seed potato trade and standards, the seed potato bottleneck in the entire region can be successfully broken in a progressive manner. This will lead to increased contribution of the potato subsector to achieving the 6% economic growth target set by NEPAD by 2015 and the MDG.

B.3 CIP Partnership Philosophy for Promoting Potato Seed Business

CIP has declared in its vision statement that partnership is an essential component of the strategy of research for development. Hence, in central and eastern Africa, different mechanisms will be used to facilitate partnership formation. Partnerships will support both research and development (R&D) efforts—for example, the need to invest some "seed money" (risk investment) for competitive grants to conduct demand-driven research on problems that limit the profitability of seed production and sale, but prioritizing the participation of partners from different sectors of the potato value chain. The funds will be administered by the seed platforms at the national or local level. These platforms involve stakeholders from all parts of the seed value chain and these stakeholders will participate in the identification of research needs.

Partnership among research-oriented partners will also be promoted in order to find solutions to specific technical bottlenecks that reduce the efficiency and profitability of the seed business. The driver will be increasing research quality and publications through existing peer review mechanisms, but also that research results have practical application. For example, research results will be published in regional or international journals related to potato production or plant protection (e.g., *African Crop Science Journal*; *Potato Research*). In addition, mechanism of internal funding to eventually make research or other seed-related services more sustainable will be explored. These mechanisms could be linked to small tariffs or taxes on seed sold.

In other cases, a specific fund could be established to provide microcredit for farmer organizations or other private groups interested in the seed business. However, the credit would depend upon the approval of a sound business plan.

Being a research-for-development organization, CIP will pay special attention to monitor partnership formation and function in order to extract lessons and best practices. Lessons will be useful for seed-related interventions in other countries in SSA or in other potato-producing developing countries where CIP operates. In addition, the lessons could be useful not only for potato-related seed interventions, but also for interventions related to other vegetatively propagated crops such as sweetpotato, cassava, yam, and plantains that share similar constraints.

B.4 Internal Funding Mechanisms

The Roadmap comprises business development, crop research, and capacity-building strategies centered on a promising set of available technologies and indications for potential growth of eastern Africa's potato seed sector.

Nevertheless, while access to new technologies including seed is a key to sustained economic viability of agriculture, at the outset of the present plan, public sector expenditures in crop research have decreased and production and market opportunities are not sufficiently clear to sustain private sector investment. Especially as potato research remains largely dependent on public funding and markets for potato seed are incipient at best, finding new models to sustain investment is a major challenge.

Some of the potential funding mechanisms that could be used to promote partnership formation could address the challenge, at least at an initial stage. However, for the medium and long term, new funding mechanism should be explored.

Several national crop research systems offer examples of successful mechanisms for internal funding, which, together with investment by the private sector and valuing of services that are integral to the strategy for sector development, may be relevant in eastern Africa.

B.4.1 Models for funding crop R&D with application to the seed business

Funding authorities in Australia and Uruguay manage a levy for crop R&D under the realization that knowledge generated from research spills over to benefit other industries. When growers sell their crop to a buyer or processor, they pay a percentage of the farm value of their crop as a levy that is matched by the government.

The mechanism ensures that government maintains support to crop R&D even as private sector contributes to investment initiates. It has reduced development time of new varieties due to more intensive research and multiplication efforts and more flexible registration processes that allow varieties to be licensed prior to extensive tests and enable early access by growers. Acceleration of the commercialization process offsets the risk of growers who adopt technologies early and helps seed to take advantage of economies of scale.

Over and above levies, end point royalties (EPR) can be assessed on crops delivered and the sale of seed. EPR are collected prior to marketing and provide incentive to develop and manage new seed varieties for high-quality ware and seed products. These mechanisms depend on adherence to policies that recognize plant variety protection. Such arrangements allow farm-saved-seed but prohibit the sale of seed or product without permission of the variety owner. In principle, the combined mechanisms can help attract private investment and get technologies into production to achieve wider adoption and market share, but some adherents to the EPR system, however, question the relatively high costs of administration with respect to generation of funds to support technology development and dissemination.

Canada uses a "check-off" fund similar to levy but without matching government funds to support agronomic research, variety development, extension activities, communication, field days, production manuals, and facilities of direct benefit to seed growers.

In France, public research funds are complemented by EPR and seed royalty systems dedicated to build industry partnerships and develop enterprises from public sector research through farmer-member cooperatives that give farmers control and input into technology development.

In the UK, albeit at reduced levels, levies are assessed to farm-saved as well as commercially traded seed. Patent protection is more restrictive and generally places equal levies on farm-saved and commercial seed. In the U.S. commodity organizations also use check-offs and royalties to support research in seed and biotech industries.

Therefore, if in the medium term the potato seed business generates sufficient profits, the mechanisms explained above could be explored to generate a fund that can sustain research, development, and market mechanisms for the potato subsector as a whole and for the seed business in particular. However, in the short term, there will be the need to invest public funds to establish the technical, methodological and partnership basis for successful potato seed businesses in eastern Africa.

B.4.2 Additional options for internal funding

- Small fee is assessed to seed sales to "ensure" quality and obtain label or certification. The fee can be applied to training in diagnostics/positive selection and can be implemented in conjunction with a system of recognition of the resulting quality product (e.g., labeling of QDS).
- Fees can be assessed along the value chain, including to processors who will contract ware crops grown from quality seed.
- Fees are assessed for technology transfer. For example, INIA Argentina charges $600 for transfer of "SAH (*sistema autotrofico hidroponico*, or autotrophic hydroponic system), including training and transfer of knowledge resulting from research ("trade secrets" learned from experimentation with medium for growth of potato plantlets in a rapid propagation scheme for basic seed stocks).
- The project coordination unit provides technical input and experienced participants to win complementary competitive grants for research and training/business development and assesses a fee for such service.
- Fees applied to generate fund for grants to research or implement best practices for seed production, storage, marketing, and so on.

Table B.1 Typology of National Partners, Their Roles, and Endowments

Country	Partners	Roles	Partner Endowments
KENYA	***Public Partners***		
	Ministry of Agriculture (MoA)[1]	• Policy development and implementation • Extension services and technology transfer • Variety release and seed certification • Training of staff and farmers	• Active seed certification service • Presence of seed and potato policy • A functional national potato council • Agricultural extension manpower
	Kenya Agricultural	• Technology development and	• Research laboratories

Country	Partners	Roles	Partner Endowments
	Research Institute (KARI)[1]	dissemination • Production of breeders' seed • Variety maintenance • Capacity building	• Trained manpower • Access to public resources • Potato germplasm
	Kenya Plant Health Inspectorate Service (KEPHIS)[1]	• Variety testing (NPT & DUS) • Granting of plant breeder's rights • Seed certification and inspection of seed potatoes for export and import • Phytosanitary and quarantine	• Tissue culture and pathology laboratories • Trained manpower • Government recognition and support as certifying institute
	Agricultural Development Corporation (ADC)[1]	Certified seed production	• Resources, including staff, land, aeroponics
	Universities and Colleges of Agriculture[2]	Capacity building	• Trained personnel • Laboratories
	Private		
	Genetic Technologies International Limited (GTIL)[1]	• Commercial production of in-vitro plantlets and minitubers	• Tissue culture laboratory • Aeroponics and conventional greenhouses • Private financial resources • Seed market strategies
	Commercial farms[1] (Kisima, Milwar, Suera, Kagia, Kinyua Mbijiwe)	• Production and sale of minitubers, basic and certified seed	• Resources (cash, land, personnel) • Facilities (lab. aeroponics) • Experience in commercial seed production
	Agrochemical Association of Kenya (AAK)[2]	• Quality control and training on safe use • Supply of agrochemical and may be seed potato distribution	Inputs, knowledge
	Farmer Organizations		
	National Potato Council of Kenya[1]	Promote and regulate the potato industry	• Public and donor funds • Trained manpower
	Kenya National Federation of Producers (KENFAP)[2]	Advocacy	Recognition and trained staff
	Potato processors[2]	Supply certified seed to contract farmers	• Cash, market
	NGOs		
	FIPS-Africa[1]	Seed potato distribution	Proven small pack farm input market model
	Farm Concern International[2]	• Linking farmers to market • Commercial village model in a group	• Proven experience in commercial village model • Experience and knowledge
	Donors and Financial Partners (potential partners)		
	Syngenta Foundation[2]	• Donor and capacity building • Seed potato insurance	Funds, experience in seed insurance

Country	Partners	Roles	Partner Endowments
	Equity Bank[3]	Credit facilities and training on financial management	Cash, knowledge
	Packaging industry[2]	Supply of seed packaging materials	Supplies
UGANDA	***Public Partners***		
	Kachwekano Zonal Agricultural Research and development institute (KAZARDI)[1]	• Production of in-vitro potato plantlets, G1, G2, and G3 seed • Potato variety development and promotion • Farmer technical support	• Tissue culture and partially equipped plant pathology labs. • Access to public financial and physical resources. • Public-paid man power.
	Buginyanya Zonal Agricultural Research and development institute (BUGIZARDI)[1]	Production of basic (G3) seed	• Public physical and financial resources • Manpower
	NAADS National Agricultural Advisory Service[1]	Seed purchaser and distribution (give away to farmer)	• National recognition • Access to government funds
	Kigezi Vegetable Bamboo Pilot plant (processing plant)[3]	Buys ware—could potentially work via contracts with farmers	Market access
	National seed certification service of MAAIF[1]	Seed certification and quality control	• Limited access to public funds • Has limited trained manpower
	Farmer Organizations		
	Uganda National Seed Potato Producers' Association (UNSPPA)[1]	Production of QDS	• A registered and organized farmers association • Private physical and financial resources
	Kapchorwa Seed Potato Producers Association (KASPPA)[2]	Production of QDS	• A registered, organized, and officially recognized association • Private resources
	Kigezi Potato Producers Association[2]	Production of QDS	• Land • Experience, trained
	Nyabyumba United Farmers[2]	Seed potato consumers (buy from UNSPPA)	• Registered contract potato growe • Resources and experience
	West Nile Seed Potato Producers association[3]	Production of QDS	Resources, including land & labor
	NGO Partners		
	Africa 2000 Network[2]	• Farmer training and agro-enterprise development • Agricultural extension services	• Has been participating in farm agro-enterprise development • Has limited personnel on ground
	CARITAS-Kabale (operating in 4 districts in S.W. Uganda)[1]	• Farmer institutional development • Provision of agricultural extension services • Farm agri-business development	• Access to donor and local community funding • Possesses trained and experienced personnel

Country	Partners	Roles	Partner Endowments
		• Implementing micro-finance credit scheme targeting mainly rural women entrepreneurs	• Attached to CRS
	Private Partners		
	AGT Laboratories Ltd.[1]	Minitubers and in-vitro plantlets	Facilities, resources, experience
ETHIOPIA	***Public Partners***		
	Ethiopian Institute of Agricultural Research (EIAR)[1]	• Coordinate research produce minituber, G1, G2, and G3 seed	• Public physical and financial resources • Facilities, TC and plant pathology labs, aeroponics • Trained personnel
	Regional Agricultural Research Institutes (RARIs): Amhara, South, Oromiya, Tigray[1]	• Conduct research, multiply basic and pre-basic seed at regional level	• Public physical and financial resources • Facilities, TC and plant pathology labs,
	MoA[1]	• Seed quality regulation and variety release • Agricultural extension services	• Public resources • Trained personnel • Technology dissemination
	Regional Bureaus of Agriculture (BoA): Amhara, South, Oromiya, Tigray)[1]	Conduct extension services at regional level	• Public resources • Trained personnel • Technology dissemination
	Ethiopian Horticultural Marketing Enterprise[2]	Coordination of horticultural marketing/explore new market opportunities	• Access to resources • Marketing experience
	Regional Agricultural Marketing Promotion Agencies (Amhara, South, Oromiya, Tigray)[2]	Promote marketing and networking producers and buyers	• Access to government resources • Proximity to produce
	Potential Private Partners		
	Mekelle Institute of Technology[1]	Production of in-vitro plantlets	• Private physical and financial resources • Trained personnel
	Solagrow PLC[1]	Production and marketing of quality seed potato	• Private financial resources • Marketing infrastructure
	Getu Vegetable Seed Producer PLC, Oromiya, Holetta[3]	Multiplication and marketing of seed potato	• Resources • Marketing experience
	Haile Vegetable Seed Producer PLC, Oromiya, Woliso[3]	Multiplication and marketing of seed potato	• Resources • Marketing experience
	Ethiopian Horticultural Production and Marketing Association (private)[2]	Coordination of horticultural marketing/explore new market opportunities	Marketing experience

Country	Partners	Roles	Partner Endowments
	Farmer Organization		
	Farmer Cooperatives, decentralized[2]	Multiplication and marketing of quality declared potato seeds	Resources, including land and labor
	NGO Partners		
	Organization for Rehabilitation and Development in Amhara Region (ORDA)[1]	• Provision inputs (net, chemicals, seed potato) • Access to funds	• Access to resources • Experienced personnel
	Goal International[1]	• Farmer-to-farmer extension • Increased expertise in seed potato	• Cost sharing contribution • New model of extension
	Vita[2]	• Increased expertise in seed potato • Link to WUL	• Cost sharing contribution • Considers potato for food security
TANZANIA	***Public Partners***		
	MoA[1]	Policy issues and regulation	Public resources
	UYOLE Agricultural Research Institute, Mbeya, South Tanzania[1]	• Potato research and development • Production of basic seed	• Public physical and financial resources • Trained personnel
	Tanzania Official Seed Certification Institute[1]	• Certification of registration of seed growers • Variety testing	• Recognition • Access to government funds
	Tropical Pesticide Research Institute[1]	• Research and registration of pesticides • Phytosanitary control on plant material	• Facilities • Access to government funds
	Horticultural Research and Training Institute[2]	• Research on all horticultural crops • Training of extension officers, crop scouts, etc. • Assisting in new variety certification and registration	
	Sokoine University of Agriculture[2]	Training and Research	Access to tissue culture laboratories
	Mikocheni Agricultural Research Institute[2]	Research on plant material	Sophisticated laboratory facilities
	Potential Partners		
	Tanzania Seed Traders Association[1]	Advocacy and policy matters	Independent and privately funded
	Processors such as crisping plants, hospitality, and catering industry[2]	Produce potato products	• Access to private capital resources • Market
	Farmer Organizations		
	Commercial seed farmers[1]	Producer of QDS	Resources

Country	Partners	Roles	Partner Endowments
	Small-scale seed farmers[2]	Produce QDS	Resources
	Potato farmers[2]	Ware potato producers	Market
	Donor and NGO		
	Syngenta Foundation[2]	• Capacity building • Information dissemination	• Private financial resources
	CARITAS[1]	• Agricultural extension service • Farmer institutional development • Agricultural transformation for food security	• Agricultural extension personnel • Access to operating in 4 districts • Proximity to Uganda, Rwanda, and Burundi
RWANDA	***Public Partners***		
	Rwanda Agricultural Board (ISAR and RADA)[1]	• Agricultural research • Seed production • Local capacity strengthening	• Access to public funding • Trained manpower • Posses TC, plant pathology, and soil labs • Posses screen- and greenhouses for minituber production • Possess agricultural land for research and seed production
	Rwanda seed inspection and quarantine services (Agency in MoA)[1]	Seed inspection and certification	New agency that has its own DG and independent of RAB
	Prisons department[2]	Seed potato production	Ample land, abundant labor, public funding, storage facilities
	Higher Institute of Agriculture Busogo (ISAE)	• University-level trainings • Seed production • Technology transfer	• Trained manpower • Agricultural land • Public funding
	NGO Partners		
	Catholic Relief Services[1]	• Agricultural extension services • Agri-business development	• Experience in coordinating local and grass-root NGO • Linkage to registered farmer groups
	Potential NGOs Partners		
	CARITAS (Byumba, Gikongoro, Kibuye)[1]	• Seed potato production • Famer training and extension	• Possess greenhouses • Organized farmer institutions
	ADENYA (local NGO)[2]	• Seed potato production • Farmer mobilization and training • Agricultural extension services • Agri-business development	• Organized famer institutions • Possess greenhouses and land • Organized farmer groups
	Farm Concern International (FCI)[1]	Farmer-market linkage	• Agri-business expertise • Access to donor funding
	Framer Organizations		
	IMBARAGA syndicate	• Advocacy • Training farmers	• A registered and organized farmers' association

Country	Partners	Roles	Partner Endowments
		• Farmer institutions development/ cooperatives	• Private physical and financial resources
	Bureau Appui aux Initiatives Rurales (BAIR)	• Farmer institutions development/ cooperatives • Training farmers	• A registered and organized farmers' association • Resources
	Donors and Financial Partners		
	Research Into Use (RIU)	Financial support	Funds
	SACCO (CLECAM, UNGUKA IMF)	Savings and financial support services	Cash, knowledge

[1] Strategic partner; [2] Primary partner; [3] Secondary partner

Table B.2 Typology of Regional Partners, Their Roles, and Endowments

Partner Organization	Roles	Partner Endowments
ASARECA[1]	• Extension and service provision • Agricultural education and training • Empowerment of farmers' organizations and other appropriate bodies • Focuses on increased productivity, food security, increased income, and poverty alleviation • Potato policies and standards	• Active in 10 countries in SSA • Access to funds • Recognition • Legal entity • Link to appropriate bodies
AFSTA[1]	• Promote the use of improved quality seed • Strengthen communication with African seed industries • Facilitate establishment of national seed trade associations in Africa • Promote activities that lead to regulatory harmonization throughout Africa to facilitate movement of seed	• Access to funds • Expertise in seed harmonization • Link to appropriate bodies
ACTESA/ COMESA[1]	• Increase the commercial integration of small farmers into national, regional, and international markets • Accelerate the implementation of regional initiatives in agriculture, trade, and investment • Improve competitiveness and integration of staple foods markets in the region through improved micro- and macro-economic policies	• Recognized and influential body • Powers to regulate regional trade • Links to heads of states and other organizations
AGRA[1]	• Has integrated programs in seeds, soils, market access, policy and partnerships, and innovative finance work to trigger comprehensive changes across the agricultural system • Strengthen agricultural education and extension • Address the issue of efficient water management, and strive to involve and train youth • Promotes training of professionals to improve the critical mass	• Access to funds • Links to other organizations • Interest in building up resources, including human and natural
EAC/EASCOM[1]	• Harmonization of seed certification • Seed standards • Regional seed trade	• Access to funds • Links to other organizations • Recognized body
International NGO		
CRS[1]	• Interest in increasing productivity, food security • Dissemination of technologies • Access to funds	• Presence in several countries • Voucher model of seed distribution • Available personnel and experience • Links to other organizations
Program		
SSA Challenge Program[2]	• Involved in seed potato production • Tackle regional food security and poverty reduction issues	• Access to funds • Regional experience • Link to NARS

[1] Strategic partner; [2] Primary partner.

CIP's MISSION
The International Potato Center (CIP) works with partners to achieve food security and well-being and gender equity for poor people in root and tuber farming and food systems in the developing world. We do this through research and innovation in science, technology and capacity strengthening.

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