

Exploring the Potential of Hybrid Potato Cultivars in East Africa



Daniel Danial, Consultant

Michiel de Vries, Agronomist, Solynta

Pim Lindhout, head R&D, Solynta

Wageningen, The Netherlands, November, 2016

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Executive summary

A fact-finding mission in East Africa was carried out to discuss the potential of the usage of F1 hybrid potato for this region, and to identify interested partners from both private and public sectors to support research on this topic. The mission was implemented by Solynta, the Netherlands and took place out in two trips: the first one to Tanzania, Kenya, Uganda and Rwanda on June 26th - July 7th, 2016 and the second one to Ethiopia and Uganda on October 10th - 17th, 2016. At the second mission, also two presentations were given at the APA conference 2016 in Addis Ababa and a technical workshop in Uganda.

Potato is widely grown in East Africa by small-scale farmers in the highlands at elevations ranging from 1300 to 3000 meter above sea level. The production of the crop in the region has more than doubled in the last 20 years. The major constraint, that limits productivity and profitability in the potato value chain, is the lack of high quality potato seeds. Other limiting factors are: lack of well adapted high yielding cultivars, high incidences of diseases, inadequate crop management, poor soil fertility, inadequate ware potato storage facilities and poorly organised commercialisation.

In each country, a workshop was organised with national stakeholders in the potato food chain to discuss the concept of F1 hybrid potato and to setup research activities to study the potential of F1 hybrid potato at the national level. The stakeholders became familiar with the concept of F1 hybrid potato and understood the advantages when compared to the conventional potato breeding technology. The two most evident advantages are

1. the fast and dedicated co-creation of hybrid potato cultivars that are adapted to local conditions and to the needs of the local stakeholders in the potato food chain
2. the availability of disease-free true hybrid seeds, that can be produced in large quantities in only one growing season and hence provide excellent clean starting materials for the local potato production systems

It is also well understood that the introduction of F1 hybrid potato seeds requires adaptations of the cultivation technologies and distribution systems. Especially, the dissemination of knowledge, technologies and materials, that are typical for potato hybrid seeds, may offer the greatest challenge. The feasibility study on the usage of hybrid potato seeds in East Africa can only successfully be achieved in coordinated actions of private and public partners with clear roles, tasks and responsibilities of each partner. A major part of the workshops focused at this multi-stakeholder approach.

Table 1. Distribution of tasks and responsibilities for studying the potential of F1 hybrid potato breeding in East Africa.

subject	Private	Governments	Research institutes	Universities
Breeding	x			
Selections	x			
Cropping systems	x		x	x
Legislation		x	x	
Capacity building	x		x	x
Socio-economic Impact			x	x
Commercialization	x			

It is clear, that these activities are required at each country as the conditions, culture and structures are country specific. However, it is quite useful to stimulate interactions among the countries and to share experiences and capacity building programmes to learn from each other's experiences. In addition, exchange of information about the performance of the same experimental hybrid cultivars in different locations in the East African region will provide information about the robustness (GxE interactions) of new products. This is a very important trait for resilient cropping systems.

Six East-African countries are already cooperating in the "East African Community (EAC)", aiming at "enhancing food security and rational agricultural and livestock within the Community through harmonisation of agricultural policies as well as joint programmes for efficient and effective production". So, a regional research plan on the potential of F1 hybrid potato cultivars will be well-embedded.

Finally, such regional programme could also include a hybrid potato breeding programme using the best-adapted local varieties to develop dedicated African potato cultivars (Local Hero).

Potential donors that might support this initiative include USAID, Clinton foundation, NUFFIC and IITA. Additional national sources for funding could be identified at the Netherlands Ministry of Economic Affairs and the Netherlands Ministry of Foreign Affairs.

The importance of potato for East Africa

The current situation

Potato (*Solanum tuberosum* L.) is a major food crop contributing to food security in East Africa. The crop is an important cash crop and is widely grown by small-scale farmers in the highlands at elevations ranging from 1300 to 3000 meter above sea level. The production of the crop in East Africa has more than doubled in the last 20 years. With the support of the International Potato Center (CIP) and European private companies, several cultivars have been introduced and are currently cultivated. The total potato production area in Tanzania, Kenya, Uganda, Rwanda and Ethiopia is over 700,000 ha, which ranks second in the world after China. The average yield is between 7 t/ha (Table 2), which is a factor five to ten times lower than yields in Europe and USA. The consumption of potato per capita per year is 10 to 20 kg/year with Rwanda as outlier with 125 kg/year (international year of potato, 2008).

Table 2. Average Potato Production and Consumption in the top five potato producing countries in East Africa: Ethiopia, Kenya, Rwanda, Tanzania and Uganda.

Indicator	units	Ethiopia	Kenya	Rwanda	Tanzania	Uganda	total
Production	10 ³ MT	940	846	1,157	581	622	4,146
Cultivation area	10 ³ ha	162	150	133	200	90	735
Yield	MT/ha	5.7	6.8	8.9	5.3	6.9	6.7
Number of farmers	10 ³	1,870	800	720	426	240	4,056
Country population*	10 ⁶	99	46	11	53	39	248
Consumption	10 ³ MT	833	788	1,080	475	407	3,583
Consumption per capita	kg/year	11	22	125	12	15	19

Source: International Potato Centre, (2011).

*FAOStat, 2015

The five countries mentioned above are characterized by a low GDP which varies between US \$1000 and \$1,600 as well as by a low level of nutrition and education, resulting in poor human

development indicators (Table 3).

Table 3. Human Development Indicators in East Africa

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	46	57	36	38
Population undernourished (%)	41	31	34	34	21
Children 0–5 years old underweight (%)	35	17	18	17	16
Human Development Index (HDI)	0.328	0.470	0.380	0.298	0.422
Global ranking (HDI)	159	128	152	148	143

Source: International Potato Centre (CIP). 2011.

General constrains

The potato value chain in East Africa is not well developed. The major constraints are listed below:

- Lack of high quality potato seeds**
Lack of high quality seed: Availability of good quality seed in the region is very limited. Farmers usually use seed tubers, either from their previous harvests or purchase seed with unknown source from local markets. Often they use the best tubers for the local market, while the low quality tubers are maintained for as starting materials for next crop. This is a very important yield limiting factor.
- Lack of high yielding cultivars**
Most of the existing cultivars (many originated from CIP) are grown by farmers in the region and were released in the 1990s. Overtime, many of these cultivars became degenerated and lost great part of their purity due to poor practices of cultivars maintenance
- Legislation under construction**
There are several legal aspects that have not been settled in all countries yet. These concern: import of potato seeds, process to acquire protection of new varieties by breeders' rights, formal testing of advanced breeding materials, certification of testing agencies, certification of potato plants, seeds and tubers, etc.
- High incidences of diseases**
The most important diseases that seriously affect the production of potato in East Africa include Potato Late Blight (caused by *Phytophthora infestans*), bacterial wilt (caused by *Clavibacter michiganensis*, *Ralstonia solanacearum*, *Pseudomonas solanacearum* and others) and viruses (mainly PVY spp.). Gildemacher et al. (2009) found that virtually all seed potato tubers were infected with a virus. The increase of potato production also results in an increased disease incidence, especially if the cropping system is not managed properly
- Inadequate crop management and poor soil fertility.**
There is great gap between the yields at trial stations and at farmers' fields. This is due to a lack of extension services which often results in inadequate crop management like insufficient rotation causing increased disease pressure and sever topsoil erosion, as well as a lack of access to basic cropping supplies like fertilisers and protection agents.
- Lack of well-trained personnel**

Many people are trained at national universities, while quite some students follow master and PhD studies abroad. So, in general, there is a growing capacity of highly educated people in the region. However, there is no experience with testing systems for hybrid potato seeds, not for testing experimental hybrids nor for setting up commercial food chain starting from true potato seed. Therefore, capacity building is required for hands-on staff involved in these activities.

- **Inadequate ware potato storage facilities.**

Typically, farmers keep seed from their previous harvested crop under very poor conditions (usually the harvested crop is kept in piles on the floor or in bags). These conditions favour infection with pathogens that can easily spread and grow at these conditions. This results in a reduction of tuber quality and often complete rotting of tubers that are kept as starting material for next season.

- **Informal potato food chain**

Most of the potatoes in East Africa are produced by small-scale farmers, though some large-scale farms of over 100 ha exist as well (personal communication). The vast majority of seed tubers for next season is propagated and maintained by the farmers in an informal system: “farm saved seeds”.

Part of the potato tubers is sold on local markets as fresh potatoes. Due to a lack of a stable supply of high quality potato tubers, only a very small minority of 2% is processed as chips or fries by small processing plants.

Import of Dutch seed tubers in East Africa

The most limiting factor for the potato production in East Africa is the quality of seed tubers. Reliable data on the amounts of seed tubers used are hardly available. Giving the total cultivation area of 700,000 ha and the usage of over two tons of seed tubers/ha, there is a potential annual demand of 1,400,000 tons of seed tubers in East Africa. At this moment, only a very small part is purchased in



the formal market. The potential market is evident, but this requires a much better structured potato food chain.

The Dutch seed tuber potato industry is the main global producer of high quality seed tubers. The majority is exported all over the world to serve the local needs for high quality seed tubers. Recently, some Dutch potato breeding and trade companies have initiated projects in East Africa to stimulate the potato production chain by using high quality seed tubers imported from The Netherlands. The

Dutch Embassies have supported these initiatives as these can contribute to improve the food security. In order to become successful and stay sustainable, technical support and capacity building is required as well as streamlining the official procedures for import of seed tubers, certification of seed tuber production fields and legal issues, like ownership, license to sell and breeders' rights.

The present document describes the potential of hybrid true potato seeds. Though technically, the usage of true potato seed may be different from the usage of seed potato tubers, the non-technical activities as mentioned above are very similar. In this respect both systems serve the same goal and may stimulate each other.

The mission

Motivation

A fact-finding mission was carried out in Tanzania, Kenya, Uganda (2x), Rwanda and Ethiopia to explore the potential of F1 hybrid potato cultivars in the region as true F1 hybrid potato cultivars may considerably enhance the yield and profitability of the potato cultivation as well as contribute to food security and nutrition value. The mission proposal and background information is described in Annex 1.

Rationale for the advantages of hybrid potato breeding technology

The hybrid breeding technology offers the following advantages for the potato seed sector in East Africa:

- Clean seeds

The products of hybrid breeding are clean true hybrid potato seeds. These are excellent starting materials for commercial potato production.

- Fast multiplication

The hybrid seeds can be produced at high volumes in one growing season. This circumvents the laborious and time consuming process of many rounds of vegetative reproduction of seed tubers.

- Improved logistics

Clean hybrid seeds can easily be transported and stored till the conditions are optimal to start with commercial production of potatoes

- Fast breeding

Each growing season new experimental hybrids can be tested at the local environments to select the optimal cultivars that are attuned to the local needs. The selected new hybrids can be rapidly produced and made available immediately after it has become commercial.

- Improved breeding

As soon as a new hybrid variety is successful new traits can be introduced via marker assisted selection. This will result in derivatives with new resistances or other desired traits.

- Dedicated breeding

Locally potato cultivars from the farmers' fields can be used as starting material for a new hybrid breeding programme, resulting in even more adapted varieties.

The development and implementation of the hybrid potato cultivars in East Africa is a double challenge: True hybrid potato cultivars are not in the market yet and the potato food chain in East Africa is not well-organised. So, hybrid potato cultivars in East Africa can only be successfully implemented if the development and testing of hybrid varieties is accompanied by the adjustments of cropping systems based on true hybrid seeds and the improvement of the logistics of in the potato food chain. As these adjustments challenge the existing paradigms, ethical and socio-economic

studies should accompany technical studies to better estimate the impact of this paradigm shift caused by F1 hybrid potato cultivar seeds.

This challenge can only be addressed if the activities are well embedded and supporting by the local organisations in East Africa, both in the private as well as in the public sector. Therefore, a mission was executed with the following objectives:

Developments in hybrid potato breeding

The initiative for the mission was taken by the Dutch private company Solynta, that is fully dedicated to hybrid potato breeding. Solynta has developed this concept in a large R&D programme over the last decade. For its entrepreneurial attitude and development of the game-changing hybrid technology, Solynta has been awarded as National Icon by the Dutch Government.

In 2016, two other potato breeding companies, KWS and HZPC, have joined Solynta in the conviction that hybrid potato breeding will become the major breeding technology for new hybrid cultivars with new traits, that will contribute to the global food security of the growing world population in a rapidly changing climate (<http://www.kws.com/aw/investor-relations/News/KWS-to-fully-focus-on-hybrid-potato-bree/~hjra/>).

This means that Solynta is not the only player to bring the hybrid technology to East Africa. However, Solynta has taken the initiative and has offered to use proprietary knowledge, technologies and materials to investigate the potential of hybrid potato for East Africa. Solynta has already developed experimental hybrid cultivars, that have been tested at five locations in Europe and have shown to yield at a similar level as the good-old cv Bintje. Similar hybrid from the same series have already been grown in DRC in 2016 and have shown similar results (see below under DRC).

Solynta is convinced about the potential impact of hybrid breeding for East Africa and is prepared to apply its knowledge, technologies, expertise, patents and materials to support local potato systems in East Africa, even well before a commercial market introduction in other regions of the world. This is a game-changing concept. Usually, new technologies are first developed in the developed countries and, after the market has become mature, these technologies may be implemented in less developed countries like in East Africa. However, Solynta is so convinced about the great potential of this technology for East Africa that this company will not wait for commercialisation in developed countries but proposes to start immediately with research on its potential for East Africa.

Giving the successful trials with experimental potato hybrid cultivars in EU and Africa in 2016, it is likely that the first hybrid potato cultivars will become available for farmers in East Africa in the coming years. Still, a five years' period is needed to study the potentials of the technology, adjust cropping systems, capacity building programmes and strengthening the potato food chain, before the hybrid potato system will reach maturity.

Objectives

1. Exchanging ideas and visions with the stakeholders of the potato value chain to explore possibilities for developing F1 hybrid potato cultivars in the region.
2. Identify potential partners for collaboration among public and private sectors

Execution

The first part of the mission was implemented in four countries (Tanzania, Kenya, Uganda and Rwanda) between June 26th and July, 7th 2016 (see program Annex 2) by Dr. Pim Lindhout (Head of

R&D, Solynta) and Dr. Daniel Danial (consultant). The second part took place in Ethiopia in October 10 – 15th by Dr. Pim Lindhout and Dr. Michiel de Vries (Head of Agronomy, Solynta)

During the visit to the region in the first part of the mission, one-day workshops were held in each country whereby most important stakeholders of the potato value chain were invited (National Agricultural Research system (NARS), research organization, seed health and inspection services, and private/public sectors, farmers organization, International Potato Centre (CIP), International Institute for Tropical Agriculture (IITA), International Fertilizer Centre (IFDC), NGOs and representatives from the Dutch Embassy. The workshops were hosted by the Embassies of the Kingdom of The Netherlands in each country. During the workshop, the novel hybrid breeding technology was shared with the participants, followed by panel discussions to obtain the feedback and view of public and private stakeholders in the potato sector and to determine the commitment of the stakeholders to collaborate in this activity.

The second part was organised in a different way for two reasons: The political situation in Ethiopia was not stable and travel restrictions prohibited to collect all stakeholders in a workshop. Therefore, informal meetings with individuals were organised in Addis Ababa. In addition, advantage was taken from the 10th Triennial African Potato Association (APA) Conference in Addis Ababa to discuss hybrid potato breeding with a much wider African audience and to discuss public private interaction in a workshop organised by Potato World Congress (WPC).

The other change was the two-days' workshop in Uganda, whereby representatives of Burundi, Uganda and DRC discussed the results of the hybrid potato trials in DRC and further steps to implement a similar trialing site in Zombo, Uganda as well as in the cross-border region of the Lake district.

The participants are listed in Annex 3.

Country reports

Tanzania

Potato production and cropping systems

The potato value chain in the country is not well developed. The potato crop is cultivated by small scale farmers in approximately 200,000 ha, involving 700,000 households. Potato is cultivated in four major areas: the Kagera region in north-western Tanzania, Arusha near Mount Kilimanjaro, the Usambara mountains in the north and north-eastern Tanzania and in the Southern Highlands of Tanzania (Fig 1). Mbeya district is one of the main potato producers in the southern highlands of Tanzania and accounts for more 85% of the total production in Tanzania. The southern highlands are situated between 1300 and 2800 metres above sea level with a total annual rainfall of over 800 mm. The area has two main planting seasons for potatoes: the rain fed crop is planted at the beginning of the rainy season in November/December and, if possible, a second crop is planted at the end of the rainy season in May. Cultivars are usually introduced either through CIP or through the Dutch seed companies and subsequently evaluated for their suitability at different sites.

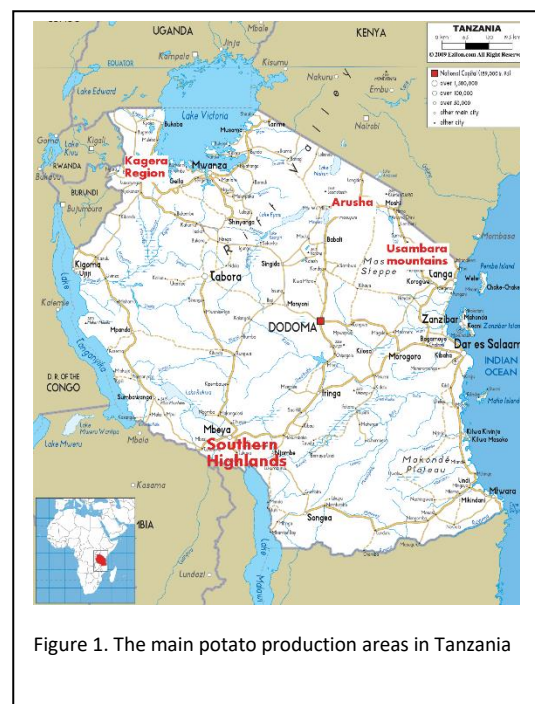


Figure 1. The main potato production areas in Tanzania

The Potato production chain is characterized by low productivity and profitability. This is mainly due to lack of high quality seed and lack of high yielding varieties. The relevant stakeholders in the potato value chain include: Ministry of Agriculture, Plant Health Services, Seed unit of Tanzania Official Seed Certification Institute (TOSCI), Mtanga farm (private potato seed multiplication company in Iringa), Agricultural Research Institute (ARI), Uyole offices in Mbeya, local agricultural officers in potato growing regions (Iringa, Njombe & Mbeya); Agriculture Selian Research Station based in Arusha and the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). SAGCOT is an agricultural partnership designed to improve agricultural productivity, food security and livelihoods in Tanzania and was established in 2010. Furthermore, a new established Dutch Company called Green Valley Agro is importing new cultivars into the country and involved in seed multiplication. Green Valley Agro has already contacted Solynta to show its interest in hybrid potato, but was not able to join the meeting.

Seed policy and certification of cultivars

Recently, the potato crop has become a focus crop by the Dutch government as an extension of the good relationships and experience with Kenya in the last four years, whereby almost 50 potato cultivars were released. These cultivars mainly originated from the Dutch seed company Agrico, that has been awarded with the ambassadors price for its international activities. The week before, the Dutch Minister of Agriculture, Martijn van Dam visited Tanzania to sign an MoU between the Netherlands and Tanzania aiming to facilitate and accelerate the introduction, evaluation and certification of new varieties. These procedures are facilitated by the Tanzanian Official Seed Certification Institute (TOSCI). The major activities of TOSCI include field and seed inspection, sampling, seed testing, variety evaluation and verification through National Performance Trials (NPT),



Photo 2. Meeting with the Tanzanian team From Left to right standing at the back: Dr. Zacharia Malley, Ms Theresia Mcha, Dr. Bert Rikken, and Dr. Mdili; sitting in front: Dr. Pim Lindhout and Dr. Daniel Danial

uniformity and stability test and control plot testing. Plant materials are imported into the country upon request from TOSCI. After importation, a careful examination of the introduced materials is assessed, whereby introduced cultivars are examined for quality and phytosanitary requirements. If the introduced planting materials proved to meet the standard quality of TOSCI, they are certified for evaluation and commercial use.

Currently, four certified cultivars in Tanzania were introduced, tested for their adoption and utilization and certified by TOSCI. Introduced cultivars through the Dutch private sector are evaluated for one growing cycle and subsequently certified for

commercial production, provided that they meet the Tanzanian requirement in terms of adaptability and quality.

Financial resources that are required for supporting research activities in the country are very limited or even absent.

Workshop on F1 hybrid potato cultivars

The number of participants in the workshop in Tanzania was limited as only two representatives from the Dutch Embassy, two from Tanzania public sector and two from Solynta participated (Annex 3).

Other stakeholders had been invited and shown their interest, but were unable to participate. This was also due to the chosen location of the meeting, Dar es Salaam, where the Embassy is located, but which is remote from the major potato growing area's.

Despite this low number of participants, the mission was able to collect the desired information from the audience.

The concept of hybrid potato breeding for developing F1 hybrid potato cultivars was highly welcomed and well received by the participants as they have shown high interest and were committed to take part in this initiative. From previous meetings in the Netherlands with Green Valley Agro, the directors Pieter van Dijke and Marcel Biest have shown their interest to take part in this initiative. The idea is to evaluate experimental F1 hybrid cultivars by Green Valley Agro to select the most promising cultivars for commercialisation. To this end, Green Valley Agro should collaborate with ARI and TOSCI to organise this process of evaluations in the national performance trials aiming at official release and commercial production.

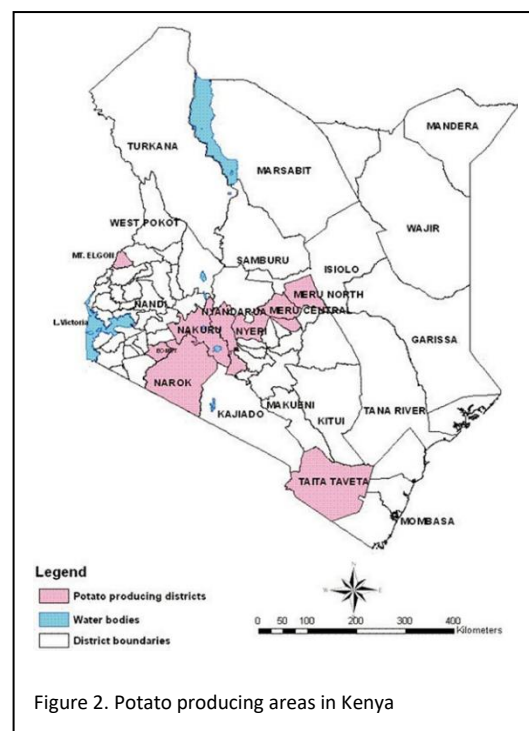
Conclusion about perspectives of hybrid potato in Tanzania

It was recommended among the participants to develop a concept note describing the strategies and plan of work that is required to address activities related to breeding aspects, legislation, agronomy, capacity building, social impact and commercialization & dissemination of the new technology.

Kenya

Potato production and cropping systems

Potato has been introduced into Kenya in the first decade of the 20th century. It is currently ranked as the second food crop after maize, with a production of 800,000 tonnes in 2007. Over the past 30 years, the crop has grown in importance, both as a staple food and as a source of farmer incomes. The cultivated potato area in Kenya occupies 150,000 ha whereby a total of 800,000 farmers are involved. The crop is cultivated mainly by small scale farmers (average 1.6 acre / farm), while five to ten larger-scale growers have farms of 100 acre. Cultivation is concentrated in highland areas ranging from 1200 to 3000 metres above sea level. These areas include the slopes of Mount Kenya, such as Meru, Embu and Kiringa, parts of Laikipia and both sides of the Nyandarua (Aberdare) range that covers parts of Nyeri, Muranga, Kiamba and Nyandarua Districts. Potatoes are also grown in the highlands on Mau Escarpment (Mau Narok and Molo) Tinderet, Nandi Escarpment and Cherangani hills. Small acreages are also cultivated in the Kericho and Kisii areas and



isolated patches near the coast in the Taita Hills (Fig 2). Only two to three percent of the potato production is processed, while the existing infrastructure and capacity for processing is larger.

The most popular potato cultivars in preference order among the farmers in Kenya are:

1. Shangi (has more genetic affiliation with CIP germplasm) occupies more than 50 % of the cultivated area. This variety has a round shape and is characterized by medium shallow eyes, short period of dormancy, good taste and has multipurpose usage.
2. Rubin originates from a Dutch introduced variety but its way of introduction is unknown.
3. Kenya Karibu originates from CIP.

Research and breeding activities are carried out and coordinated by the Kenya Agricultural and Livestock Research Organization (KALRO). The centre collaborates closely with Kenya Plant Health Inspectorate Services (KEPHIS) for seed inspection, International Potato Centre (CIP), Universities, National Potato Council of Kenya (NPCK), Non-Government Organizations (NGOs), Community Based Organization (CBOs), individual growers, private companies e.g. Syngenta and Agrico and potato processors.



Photo 3. Tuber seed increase of the most popular potato variety in Kenya “Shangi” at Tigon Research Centre in Limuru.

Major constraints

Currently, potato is cultivated in 25 counties and the government is doing all efforts for providing the required funding for seed multiplication as potato is considered important for food security. Moreover, potato yield is very low (Table 2.).

A major bottleneck is the availability of good seed tubers. Seed companies are importing seed tubers into Kenya to produce seed tubers for the local markets in Kenya by several rounds of multiplication. Hundred thousand tons of seed tubers are required to satisfy the market need, while only 5,000 tons are imported. The use of tuber seed multiplication by the farmers for replanting in next season (farm saved seeds) forms a high risk due to bacterial wilt (= brown rot, caused by *Ralstonia solanacearum*). The majority of potato producers favours to get access to high quality seed.

Dr. Luiske Wasilwa (KALRO) called upon the private sector to support the public sector and work hand in hand with KALRO, while Dr. Bert Rikken (Dutch embassy) stressed the importance of enabling environment by the public sector for attracting investors that lead to creating more business opportunities and stimulating economic growth. Constraints that limit business growth should be addressed and the public sector should support the private sector.

Seed policy and certification of cultivars

Similar to Tanzania, an MoU has been signed between the governments of Netherlands and Kenya. Cultivars can be introduced and tested for performance and adoption at the national level. The introduced cultivars can be evaluated for one year during two growing cycles and subsequently the

performance of cultivars is examined by the National Variety Testing Committee and the National Variety Release Committee for certification, registration and commercial release. According to KEPHIS, a total of seven testing sites is required as a minimum to test the introduced variety. New materials are tested according to Distinctness, Uniformity & Stability (DUS) for two years. Experiences with cropping systems based on seed raising are present but this technology should be optimized and improved in the near future.

Tanzania, Uganda, Rwanda and Kenya have harmonized their procedures for introducing new varieties (see chapter EAC). This may limit the number of evaluations to get licence to produce and commercialise.

Visit to National Potato Centre (KALRO) in Tigoni

A visit to the National Potato Research Centre (KALRO) at Tigoni (52 staff members) was made by the mission whereby potato research is carried out. Research activities consists of breeding, basic seed production aiming at providing pre-basic seeds to potato growers in collaboration with KEPHIS, agronomy, crop protection, postharvest storage, food processing and socio–economics. The pre-basic seed facilities at Tigoni also comprise technologies like tissue cultures, aeroponics, hydroponics, seed cutting and conventional field multiplication.

The centre has a small breeding programme, whereby mainly the general combining abilities of existing tetraploid varieties were examined.

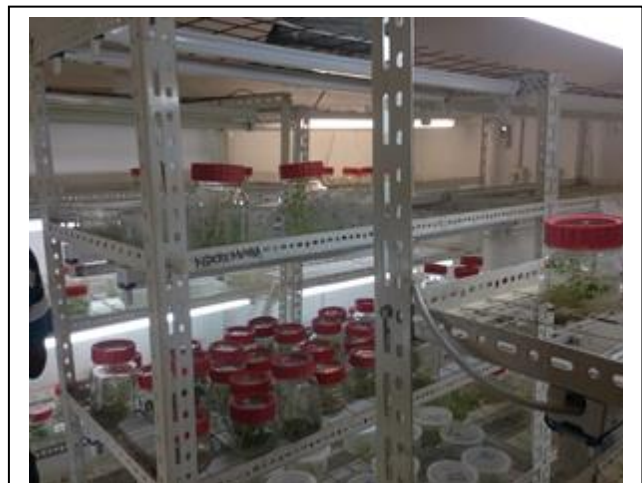


Photo 4. Tissue culture facilities for increasing potato seed tubers at Tigoni Research Centre in Limuru.

Workshop on F1 hybrid potato cultivars

The new technology of developing F1 hybrid potato cultivars is well received by the participants as it offers many advantages when compared with the existing breeding technology.

Based on KALRO experiences, Dr. Lusike Wasilwa underlined the importance of enhancing capacity building for the cropping system and improved technology in seedling multiplication when using true potato seed. There is experience in a tomato project, whereby 85% of the tomato growers have failed in producing tomato under protected environment (plastic greenhouses), due to lack of appropriate technologies, like the efficient production of seedlings. Therefore, seed raising technology in potato should be investigated, managed and disseminated properly. This includes a certification body for regular inspection of seedling production to ensure high quality seedlings and uniformity. So, seedling experiences are present, but capacity building is required in the fields of disease testing, diagnostics and certification protocols.

Dr. Maarten van Ginkel, working as consultant and representing the largest seed company in Africa (Seed Co, an African seed company with 110 m\$ sales) has indicated the interest of Seed Co in evaluating and selecting promising F1 hybrid cultivars in Kenya. He shared his experience with hybrid technologies in rice, whereby F5s have been distributed over other private companies, whereby each company makes its individual selections in F6 and F7 populations to produce its own hybrids. Such approach can also be applied in potato and we have to find the best business models. This also includes the organisations of National Performance Trials (NPTs), which are located at several sites in and outside Kenya and of demo plots to reach small farmers. Seed Co is also interested to collaborate with Solynta in other countries such Angola, Malawi, Zambia, South Africa, Mozambique and Zimbabwe.



Photo 5. Meeting with the team of Kenya Agricultural & Livestock Research Organization (KALRO) in Nairobi. Standing from left to right: Dr. Pim Lindhout, Mr. David Kikwai, Dr. Lusike Wasilwa, Dr. Daniel Danial and in front Dr. Moses Nyongesa.

Dr. Moses Nyongesa (head potato research at Tigoni, KALRO) is responsible for the potato breeding activities of KALRO in Tiboni. He has gained experiences with socio-economic impact studies and he offered his support for similar studies on the impact on hybrid potato cultivars in Kenya. Again he emphasized the importance of the adoption and dissemination of the introduction of the hybrid potato breeding technology in Kenya.

Availability of funding was addressed. According to Dr. Wasilwa, a concept note has to developed and submitted to the permanent secretary of agriculture whom is responsible for making funds available to KALRO and might assign budget for F1 hybrid breeding. In addition, International donor communities, like USAID and World Bank Climate Smart Agriculture should be explored.

Dr. Melle Leenstra from the Dutch Embassy in Nairobi and future senior policy maker for the Dutch Government in the field of support for international organisations (CGIAR-CIP) will become responsible for the Dutch policy of international research programmes. In the near future new multiyear plans will be established on specific research area's and crops. Giving the potential of hybrid potato breeding the subject of F1 hybrid potato breeding may be included in these programmes

Conclusion about the perspectives of hybrid potato in Kenya

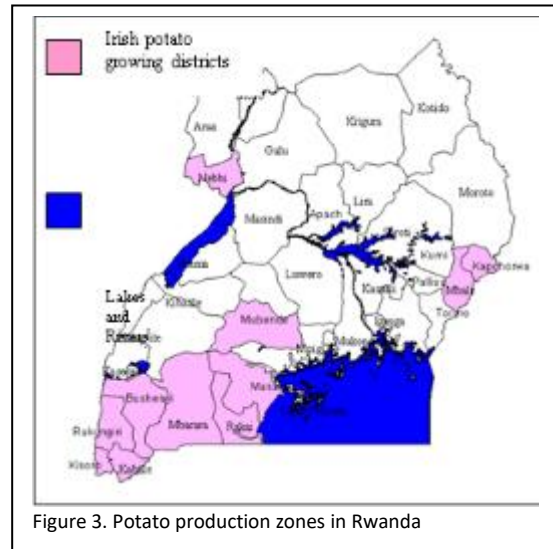
The offered technology for developing F1 hybrid cultivars is well received and described by KLARO as a fantastic alternative for enhancing the potato productivity that can lead to optimizing the potato value chain in Kenya. In the meantime, the participants were very positive about the technology and expressed their interest for bringing it into Kenya as quickly as possible. KLARO together with KEPHIS and Eldoret University have shown their commitments and interest to collaborate with Agri Seed Company for facilitating the seed importation and testing the introduced genetic materials with Seed Co.

Uganda

Potato production and cropping systems

Potatoes are cultivated by small scale farmers and are traditionally grown in the highland areas of Uganda, 1500 – 3000m. The major production zones include:

- (i) the Kigezi highland districts of Kabale and Kisoro in the south west, which produces the bulk of the crop in Uganda,
- (ii) Mbale and Kapchorwa districts on the slopes of Mount Elgon and
- (iii) Nebbi district, a mid-altitude region in north western Uganda which has more recently started to promote potato production (Fig 3).



Since 1990, potato production has increased from 224 000 tonnes to a record 650 000 tonnes in 2007.

In the same period, the area under potato tripled to 90 000 ha. Almost half of the national production comes from the intensely farmed Kabale highlands at 2 000 meters above sea level, with yields of 6.9 t/ha.

Two main production seasons are distinguished, coinciding with the short and long rainy seasons. However, in Kabale district, a third cropping season can be recognized after the short rainy season. During this period, potato is planted in valley bottoms or drained wetlands. The crop is supported by the residual moisture available in the rich organic soil or drainage water coming from the surrounding hills.

The National Agricultural Research Organization (NARO) officially coordinates all agricultural research activities in the national agricultural research system such as plant breeding, agronomic practices, seed multiplication, extension services and varietal release and certification, while NARO also collaborates with universities.

The first workshop on F1 hybrid potato in Entebbe, Uganda

Dr. Herman Fleer, director of Lake Albert Investment active in DRC, shared his expertise with the participants on the evaluation of the first test in East Africa with experimental hybrid potato varieties, that are grown in the Democratic Republic of Congo (DRC) in 2016. Giving the success of this first trial, a similar private experimental site might be settled in Uganda. It is expected that Lake Albert might be a strategic partner and could play a very important role together with NARO in evaluating and testing introduced F1 Hybrid potato cultivars.

From the workshop held in Entebbe, participants became familiar with the F1 hybrid technology. In addition, the experience of testing & evaluation of F1 hybrid potato cultivar in DRC was shared whereby the procedures from planting to harvesting was demonstrated. This experience was based on the involvement of the private sector whereby a research centre is established and a business plan is developed. It is expected that in two years period, the first potato hybrid is developed for release and in five years' time the first potato hybrid with late blight resistance is obtained. Hybridization of local materials is expected to take 8 to 10 years. By doing so, desired traits are examined and developed for fit into the market needs.



Photo 6. Participants of the workshop in Entebbe, Uganda.

In view of the participants and under the given infrastructure and the existing facilities in Uganda, the new technology is a breakthrough for improving the productivity of the potato in the country.

The second hybrid potato workshop in Arua, Uganda

The successful trial in Nioka, East DRC (see above), has encouraged Uganda to identify a farm in Zombo to test experimental potato hybrid cultivars in Uganda. This farm can be managed by LAI based on cooperation with Muni University and the National Agricultural Research Institute NARO-Abizardi. The facilities will be ready by the end of 2016 and the first trials will start in early 2017.

For a successful trialing site, capacity building and training courses of the local agronomists are a prerequisite. Therefore a first workshop has been organized at the Nioka farm in East DRC and a second in October 12th – 13th in Arua. The participants of this workshop represented the Nioka farm from East DRC and institutes, universities and government officials of Uganda. In addition, three representatives from Burundi (national research institute, university and seed certification institute) also participated as Burundi is also eager to learn more about hybrid potato.

The first day was focused on the general technical and scientific aspects of the concept of hybrid potato breeding presented by the inventor of hybrid potato breeding Pim Lindhout, founder and head R&D of Solynta. The second day was focused on the recent results with field tests of hybrid potatoes, both in Europe as well as in the Nioka farm in DRC and the consequences for Uganda, presented by Michiel de Vries, agronomist at Solynta. Though not all participants fully understood the scientific aspects of the concept of hybrid breeding, they all very well understood that hybrid breeding is much faster than conventional breeding and the hybrid varieties become available as true seeds, that has tremendous logistical advantages as well as are clean: devoid of any pathogens. The results of the trials with seedlings from the very first hybrid varieties both in EU and at the Nioka farm were convincing that in one season high yields can be obtained both for seed potato tubers and consumption tubers. This has great advantages as the farmer will be more flexible to the market demands.



Photo 7. Participants of the workshop in Arua, Uganda.

Abi Zardi, NARO, Arua

The national research institute in Uganda has several regional stations, Abi Zardi in Arua is one of them. Mozes Kiryowa is a PhD student of Makerere University, who studies advanced genetics, is the crops breeding programme lead, that mainly consists of maintenance, propagation and testing of existing cultivars. The level is very applied in large contrast with his PhD study whereby he uses advanced genetics technologies. The director is Sadik Kassim, who got a PhD from Makerere University, and obtained this position in spring 2016. Both showed a great interest in hybrid potato breeding, whereby they considered that this technology is also suitable for other vegetatively propagated crops like cassava and sweet potato. NARO cooperates with Muni University and Lake Albert investments.



Photo 8. Visit to cultivar trials at Abi Zardi, NARO, Aruha, Uganda.

Conclusion about the perspectives of hybrid potato in Uganda

It is recommended to support the private sector for this initiative and investigate the possibility of developing an economic model that serves Uganda, DRC and South Sudan. Moreover, community based institution jointly with the private sector are encouraged for enhancing capacity building among students in partnership with R&D. Finally, The National Agriculture Research Organization (NARO) is willing to take up the technology.

Rwanda

Potato production and cropping systems

Potato is considered as the country's second most important crop after plantains and, in the sub-Saharan region, Rwanda is the third largest potato producer. Since 1961, Rwanda's potato output has risen from less than 100 000 tonnes to 1.3 million tonnes in 2005. The crop grows well in several parts of country - mainly above elevations of 1 800 m - and some areas grow two crops a year. Most of potato sector consists of small family farms that intercrop potato with beans and maize, and yields average almost 10 tonnes per hectare. According to the Rwanda Agricultural Board (RAB, 2012), potato has become an important food crop in Rwanda with about 133,000 hectares under cultivation and more than 1 million MT of potatoes produced. The important producing area are situated in the Northern

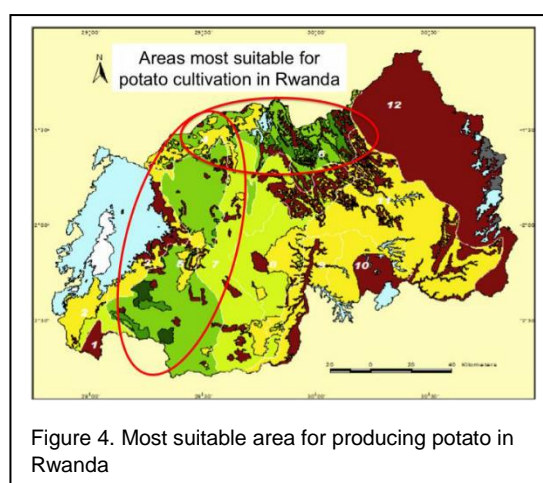


Figure 4. Most suitable area for producing potato in Rwanda

and western part of the country and include Musanze, Burera, Gicumbi and Nyabihu that account for 90% of the national potato production (Fig4).

The potato production growing cycle is short compared to maize with 3-4 months and follows two main growing seasons (February to May and September to December). However, in some regions it is possible to extend the growing cycle beyond those seasons if sufficient moisture is available in the soil. According to RAB, the consumption is reported to reach as much as 250kg per person per year and is on average significantly higher than other country in the region e.g. consumption per capita per year in Kenya and Ethiopia is 25 kg and 5 kg, respectively.

The potato value chain in the country exists of Rwandan Agriculture board (RAB), universities e.g. Rwanda University, International Potato Centre (CIP), International Fertilizers Development centre, (IFDC), farmers' associations. RAB is usually dealing with importing, evaluation of germplasm and disseminating of technology to farmers. For importing true seeds into Rwanda, a request has to be submitted to RAB. The experience of Ecopolis in DRC could serve as a model and benefit Rwanda as well in collaboration with RAB.



Photo 9. Participants of the workshop in Kigali, Rwanda.

Farmers have the tendency to grow potatoes without adequate rotation and limited use of organic matter which cause a real concern for soil degradation and loss of fertility over time. In addition, potato production is heavily dependent on pesticides, with as many as 8 applications of 3 different chemicals during each season. The combined cost of potato seeds, pesticides and land preparation makes the potato production one of the most expensive food crops, however this is largely compensated by the high yields

Workshop on F1 hybrid potato cultivars

The workshop on exploring the potential of F1 hybrid potato cultivars was opened by the Ambassador of the Royal Netherlands embassy Ms. Frederique de Man and facilitated by the Teddie Muffels. Representative from RAB, CIP, IFDC, Rwanda University, Bill and Meredith Gate Foundation and an agricultural officer, were present.

The F1 Hybrid technology in potato was presented by Dr. Pim Lindhout whereby the participants got familiar and acquainted with it. Based on the questions that were raised by the participants, the following clarification was provided by Dr. Lindhout

Up to present, there is no ready-made F1 hybrid in the market, and it is expected that the first F1 hybrid variety will be launched in 2018 whereby additional two years is required for multi-testing locations for official certification and release for commercial production. In 2018, stacking of traits for late blight resistance can be initiated in the same F1 hybrid which might last 5 years. Breeding for other desired traits such as abiotic constraints or quality, will follow but require more time varying between 5 to 7 years.

Information on expected yield and costs of implementing such technology when compared with the conventional technology using potato seed tuber is not yet available and has to be established.

Training is required in the area of agronomy and crop management and not in breeding.

It is unknown for how many generation farmers can re-use harvested crop for replanting. Cost/benefit study has to be worked out to investigate for many generation farmers can re-use harvested tuber seed and what are economic/technical consequences when this approach is used.

Inbred lines might be used for research activities by collaborating partners and not for commercial use after signing MTA. Breeding activities and developing F1 Hybrid cultivar will be made outside Rwanda and seed will be made available for interested farmers.

The F1 Hybrid technology is welcomed by all the participants RAB was very open to collaborate with the private sector. Moreover, regional collaboration is encouraged and recommended.

Clinton Foundation proposed to offer experimental field for testing and evaluation or forwarding introduced materials to RAB for direct testing.

RAB together with the Dutch Embassy will coordinate further follow up and will take the lead to come up an action plan.

Conclusion about the perspectives of hybrid potato in Rwanda

The Rwanda stakeholders for testing hybrid potato are all from public institutes, that are used to control the potato food chain. No private industries have been identified. This is crucial for the sustainable implementation of hybrid potato in Rwanda. Lake Albert Investment is exploring the possibilities to extend its activities into Rwanda.

Democratic Republic of Congo,

The original intention was to also visit East-DRC, as in the region the first hybrid potato cultivars are being tested. However, some changes in the workshop schedule in Uganda made this impossible. Still, as this trial site is considered as a pilot for testing and implementing F1 hybrid potatoes, this testing site is described below.

The region around Lake Albert, comprising eastern parts of DRC and the western parts of Uganda and Rwanda is considered as one climatic and agricultural unity. Unfortunately, this Lake Albert District has suffered a lot from tribal wars in the last decades. The genocide in Rwanda in 1992 represents the worst recent example.

Where the governments of Rwanda, Burundi and Uganda have policies to strengthen agriculture, East-DRC is so far away from the capital of Kinshasa, that it can be considered as a liberal area, with little emphasis on agricultural policies. In the past, the better parts of this region have been granted as a concession to individuals, who were free to cultivate such concession. Usually these concessions have got little attention. The DRC government is positive to develop agriculture in this region as an alternative for the big mines, that represent a lot of value but also are a threat to peace.

Lake Albert Investment is an agricultural company that has established a test farm in such concession, located highlands of the Albertine Rift at Nioka, Territoire de Mahagi, at Ituri Province in DRC. The aim is to test commercial cropping systems for large scale inclusive agro-development. To this end, collaborations have been established with knowledge centres, government and NGOs.

Lake Albert Investment has started testing the first experimental hybrids experimental hybrids derived from the European hybrid breeding programme of Solynta. Seeds have been sown in January 2016 and seedlings have been transplanted into the field (Photo 7). These hybrids were evaluated in good cooperation with local farmers and the results are shared with the Solynta breeding program.

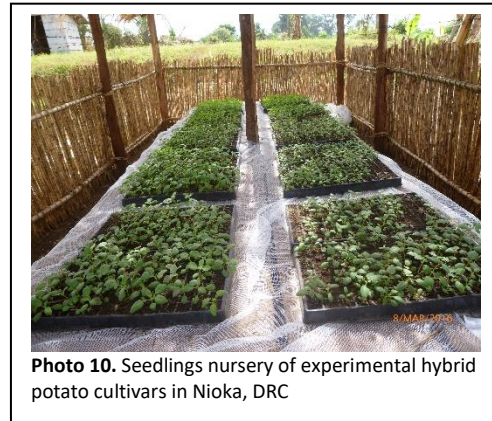


Photo 10. Seedlings nursery of experimental hybrid potato cultivars in Nioka, DRC

The crop was harvested in July and several individual plants produced a significant number of tubers, equivalent with 30 tons/ha, some factors higher than the national average. This is remarkable as these were the very first experimental F1 potato hybrids ever without any selection for agronomic performances.

These data are used to adjust the selection of inbred lines to the needs in East Africa and to continuously generate new experimental hybrids, that will be tested at the Congo farm again. This iterative and interactive process may already select the first dedicated hybrids for East Africa in 2018 or 2019.

This breeding program is accompanied by research on cropping systems for the region. In addition, training programs for research institutions, agronomists, local staff and interested farmers in the regions will make the farmers' communities and relevant institutions familiar with the new concepts of hybrid potato cultivars. Also market studies are needed to identify and secure stable and sustainable markets for the farmers' potato products. This market may comprise other countries in the Great Lakes Region (South Sudan, Uganda, Burundi and Rwanda).



Photo 11. Harvesting tubers per plant of experimental hybrid potato cultivars in Nioka, DRC

Hybrid potato at Nioka Farm in East DRC

In 2016 Lake Albert Investment (LAI) started a hybrid potato experimental farm in Nioka, East-DRC. Both Henk Peters (LAI) as well as Michiel de Vries (Solynta) reported about the first trial that was so successful that one out of the ten experimental potato hybrid varieties tested, yielded already 30 tons/ha., from transplanted seedlings into the field, four times the country average. This success already triggered LAI to send more seeds of this experimental variety to build up seed tubers for commercialisation. However, this experimental variety does not match the requirements for official variety registration and therefore, Solynta decided to continue with next generation hybrids, that are being cultivated in the winter-crop season in East DRC.

This first trial with the first experimental hybrids in East Africa already proved the potential of clean hybrid seeds for East Africa. These results have been shown at various formal occasions like workshops and conferences as well as at informal meetings in East Africa. The other neighbour countries in the Lake district: Uganda, Rwanda and Burundi all have expressed their interest and are prepared to start testing the potato hybrids as well.

Conclusion about the perspectives of hybrid potato in DRC

The very first trial with diploid hybrid potatoes are successfully applied in DRC. The testing of new series of experimental hybrids is underway.

The set-up of the testing station in Nioka may serve as blue-print for other countries

Ethiopia

Instability in Ethiopia

The situation in Ethiopia (80 million people) is unstable. The minority tribe Tigray (6%) in the north of Ethiopia dominates the government, army and police. The two major tribes Amhara (30%) and Oromia (30%) feel discriminated and started demonstrations and attacks on government premises. As these are well protected by army and police, they have changed their attack-targets to foreign investments, that are considered as extensions of the government. This has already caused the departure of several private companies, including Dutch companies in flower production. Solagrow has lost several farms and licence to operate of some farms and is close to bankruptcy, but still determined to continue. As alternatives to Solagrow, Amsalu Ayana will draft a list of potential candidate companies which could take up the role of local partner for us. Enza's local entity has been suggested as one.

APA Conference 2016 and WPC workshop

Participants of most African countries participated in the APA conference and also some from European countries like The Netherlands and Germany, India, China and Peru, mainly from CIP headquarters in Lima. Nearly 200 participants had an oral or poster presentation.



The oral presentations were dominated by CIP and has a more applied scope. Only one presentation of advanced genetics by Andrew Kinggundu, who showed his results on GM-potato (see below).

We mainly used this conference to present hybrid potato breeding and the recent results of the 2016 field trials and to have informal meetings with interested researchers and breeders, including those of CIP. This has resulted in several initiatives for cooperations. In general, there were more presentations about sweet potato than about potato. For potato, most presentations focussed on tuber-associated problems. Some highlights of presentations:

- Graham Thiele, director RTB CGIAR, CIP, Peru gave a high-level presentation about challenges related to global trends and climate change. He calls for smart, fast and effective breeding and R&D to develop climate change adapted varieties. Pim addressed these phrases in his presentation.
- Andrew Kiggundu, NARO, Entebbe, Uganda: Excellent relaxed presentation on transgenic potato with one, two or three resistance genes corresponding to Durph, even including communication strategy and stakeholders' visits. Support from Simplot, 2Blades (TSL, Norwich) and US Aid.
- Anton Haverkort presented his experiences with public private partnerships with Dutch companies in projects targeted on Africa.
- E. Carey, CIP Ghana presented the sweet potato programme that has won the global food price. The target is to reach 10 million people in sub-Saharan Africa with better sweet potato varieties including orange varieties with high carotenoid level. To achieve this an accelerated breeding scheme is used: early multi-locations testing, increased number of evaluations per site. High yielding orange flesh variety released in four years in Mozambique. In Uganda, orange flesh, high yielding, 35 ton/ ha, moderately resistant to SPVD and high dry matter content. Still most varieties in introduction phase. More examples of other African countries.
- Kenya. In Kenya with the aid of Dutch government Agrico and HZPC have introduced new varieties and results of national variety trials were presented by Simeon Komen. Also Wachiro Kaguongo of the national potato council was present. In total 33 varieties have been released, from more than 100 tested. Testing is needed over 2 seasons (long and short rainy seasons) and 7 locations.

Conclusion about the perspectives of hybrid potato in Ethiopia

The company Solagrow is technically well-positioned to participate in a hybrid potato project.

However, the political stability in Ethiopia is at present so low, that private investments are too risky.

Therefore, the political situation in Ethiopia has to be improved before further steps are taken.

Burundi

Some Burundi researchers participated in the workshop in Arua, Uganda. This was a very first contact and insufficient to pave the way for research on hybrid potato.

CIP

CIP has a strong presence in East Africa and may be helpful in exploiting the hybrid potato technology:

- CIP has a global mandate to develop potato varieties for developing countries
- CIP has a strong research and dissemination platform in East Africa
- CIP has unique germplasm that is valuable for hybrid potato breeding in East Africa
- CIP has a strong network in East Africa that can be used for the dissemination of knowledge, technologies and materials

The first contacts with CIP on hybrid potato breeding date back to 2011 when the first presentation about hybrid breeding was presented at an EAPR meeting in Oulu, Finland. Initially, there was great

concern and scepticism about the access of hybrid potato seeds to small farm holders in developing countries. Since then CIP researchers have frequently interacted with Solynta on collaborative effort of diploid genetic research and potato hybrid breeding. This has strengthened the understanding of the value of hybrid potato breeding and the vision that public private cooperations may provide the new paradigm to support food security in developing countries. As a result, the CIP board members, Barbara Wells, Oscar Ortiz and Jan Low have visited Solynta in March 2016.

At the APA conference in Addis Ababa, CIP potato geneticist Merideth Bonierbale and CGIAR director of Root & Tuber crops and Banana (RTB), Graham Thiele, discussed the potential of hybrid potato and the role of CIP. We agreed that CIP may play a role in pre-breeding research to develop tools for breeding like diagnostic markers and pre-breeding germplasm, like heat tolerance, as well as in the dissemination of knowledge and new hybrid cultivars to the small farm holders.

Pim Lindhout presented the opportunity of CIP – Solynta research cooperation and Michiel de Vries about the role of CIP in dissemination to farmers in their presentations. Remarkably, CIP-people commented that CIP cannot play the latter role. Finally, Graham Thiele openly discussed the role of CIP in the past and future. Basically, CIP role has changed from a global universal mandate in potato R&D into a role as partner in joined R&D projects whereby CIP can contribute based on its unique germplasm and expertise.

Merideth Bonierbale and Pim Lindhout have contributed to the design of an EU H2020 research project that has not been funded. The aim was to genetically dissect heat tolerance and develop breeding tools to breed for heat tolerance. Such research could be part of the regional programme in East Africa to develop a dedicated hybrid variety: Local Hero. This proposal may be earmarked in the Dutch contribution to CIP.

East African Community (EAC)

The four countries visited in the first trip of the mission are partners in the East African Community. This means that these countries aim to harmonize their legal procedures, including seed import, breeders' rights and certification & phytosanitation protocols. This has been made clear during the workshops. Therefore, this community is described here in more detail.

From the EAC website: *“The East African Community (EAC) is a regional intergovernmental organisation of 6 partner states: the Republics of Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania, and the Republic of Uganda, with its headquarters in Arusha, Tanzania.*

The EAC is home to 158 million citizens, of which 22% is urban population. With a land area of 2.42 million square kilometres and a combined Gross Domestic Product of US\$ 169.5 billion (EAC Statistics for 2015), its realisation bears great strategic and geopolitical significance and prospects for the renewed and reinvigorated EAC.

The work of the EAC is guided by its Treaty which established the Community. It was signed on 30 November 1999 and entered into force on 7 July 2000 following its ratification by the original three Partner States - Kenya, Tanzania and Uganda. The Republic of Rwanda and the Republic of Burundi acceded to the EAC Treaty on 18 June 2007 and became full Members of the Community with effect

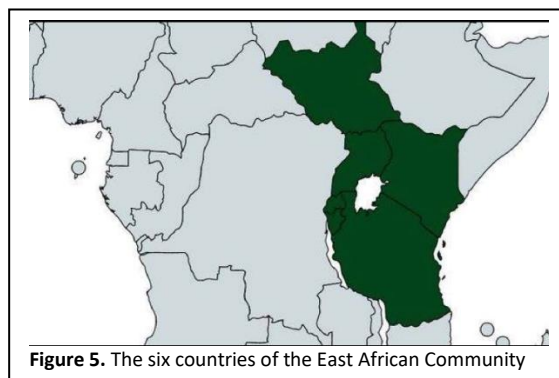


Figure 5. The six countries of the East African Community

from 1 July 2007. The Republic of South Sudan acceded to the Treaty on 15 April 2016 and shall become a full Member once the instruments of ratification of the Treaty are deposited with the Secretary General of the Community.

As one of the fastest growing regional economic blocs in the world, the EAC is widening and deepening co-operation among the Partner States in various key spheres for their mutual benefit. These spheres include political, economic and social.

At this moment, the regional integration process is in full swing as reflected by the encouraging progress of the East African Customs Union, the establishment of the Common Market in 2010 and the implementation of the East African Monetary Union Protocol”.

One of the aims of EAC is: “enhancing food security and rational agricultural and livestock within the Community through harmonisation of agricultural policies as well as joint programmes for efficient and effective production”.

Discussion

Potential of F1 hybrid cultivars

The introduction of F1 hybrid potato seed into the region, is an excellent opportunity that may contribute towards improved efficiency/functioning of the potato value chain and subsequently, improved productivity and profitability.

During the workshops a series of related subjects, that are relevant for the implementation of hybrid potato in East Africa have been addressed:

1. The establishment of public private partnership is very essential to ensure efficient management strategy in evaluation and screening of introduced F1 hybrid in the targeted zones.
2. New developed F1 hybrid have already been evaluated in DRC for their adaptability and suitability in different agro-ecological zones. The results are so encouraging that this stimulates similar trials in the East-African region.
3. Agricultural research organization facilitate importing true seed and share responsibility to further evaluate the selected cultivars in a National Performance trails and subsequently facilitate for registration and certification
4. Inbreeding lines are maintained and kept outside the region. Similarly, genetic improvement and breeding activities are carried out outside the region.
5. Two growing cycles are required for selecting F1 hybrid varieties in a targeted zone. For combining desired traits into this variety, e.g. disease resistance to late blight, an additional five years are required and for combining more traits such as tolerance to abiotic stress factors and quality, a total of 5 to 7 years is required
6. The first trial in DRC was harvested in summer 2016 and the best hybrid variety, starting from seedlings, already produced 29 tons/ha. Currently, technical and economic data are collected to estimate the cost of production and expected net profit.
7. The adjustments if existing cropping system and crop management handling due to true hybrid seeds as starting materials requires new technologies e.g. seedling production, nursery management, plant density, agronomic practices, etc.
8. Capacity building is required to train stakeholders to the new technologies and the impact on the potato value chain
9. Dissemination of knowledge and materials c.q. reaching large numbers of small farmers is an enormous challenge and requires dedicated strategies.

10. For a durable potato food network, improved access to the market and market intelligence is a prerequisite.

Consensus on business model in each country

In general, consensus was achieved about the different roles of the partners in the potato food chain in each country, comprising seven different subjects (Table 1.)

1. Breeding: development of experimental hybrids by dedicated hybrid potato breeding companies
2. Selections: testing the performance of experimental hybrids at local farms of private industry
3. Agronomy: applied and scientific studies on cropping systems by public research organizations and private farms
4. Legislation: organising legal procedures by national authorities:
 - a. seed imports and cross-border shipments
 - b. organisation and execution of national trials for breeders' rights
 - c. certification of potato products throughout the potato food chain.
5. Capacity building: programmes by private companies, national institutes and universities
6. Socio economic impact: academic studies by international centres (CIP), national institutes and universities
7. Commercialisation: by private industries

Several companies have shown their interest to join research on hybrid potato. These are:

- "Green Valley Agro" in Tanzania
- "Agri Seed Company in Africa" in Kenya
- "Lake Albert Investment" in DRC and Uganda
- "AQ Seeds" and "Solagrow" in Ethiopia.

Among the public sectors, the most important interested key players are (see Annex 3):

- ARI and TOSCI in Tanzania
- KLARO, KEPHIS and Eldoret University in Kenya
- NARO, Zonal Innovation Unit, NARO-AbiZardi, MAAIF, Makerere University and Muni University in Uganda
- RAB, INES, EKN, and National University of Rwanda in Rwanda
- FLA / NIOKA, IPAPEL MAHAGI, ISEAV/ARU, INERA in DRC
- ISABU, UB-FABI and ONCCS in Burundi

Socio economic context

The workshops aimed at identifying potential private partners and public institutions for exploratory research on hybrid potatoes for East-Africa. Though the technology of hybrid breeding is not simple and often not fully understood, the potential of hybrid true potato seeds for improving the potato cultivations systems were generally acknowledged.

There was sometimes criticism about the role of private industry in strengthening the potato food chain and contributing to food security in East Africa. Some participants were initially reluctant to accept the idea that a commercial partner is motivated to invest in research on the potential of hybrid potato mainly for reasons of strengthening the regional food security. On the long term private companies need to have a profitable business in order to establish a sustainable potato food

chain. Usually, by patiently repeating the same story, the attitude of unbelief changed into critical but positive behaviour.

In Rwanda, several participants advocated to start a full hybrid potato breeding programme at national institutes. This may reduce the dependence on private companies. However, this is not regarded as a sustainable solution as it will become even more difficult to establish a commercially profitable potato system based on hybrid seeds. This resulted in a discussion on the role of government and private industries. As the role of the government in the economy in Rwanda is quite strong, it will be difficult for a commercial company to establish a profitable business on hybrid potatoes in this country.

No representatives of farmers' groups participated in the workshops. It was considered as too premature as no hybrid potato products are in the market yet. Still the other participants showed strong and often quite different opinions about the acceptance of hybrid potato by farmers. Some believed that convincing demonstration plots should cause the easy acceptance by farmers, while others believed that farmers will show resistance for new technologies anyway. It will be difficult to predict the farmers' reaction and building trust of the farmers is a prerequisite.

The Dutch potato industry is also involved in other projects, whereby seed tubers or mini-tubers are used as starting materials for more productive potato cultivation systems. Both systems could very well go next to each other and each system should be tested to judge the value for the region. In addition, both systems require a strong potato food chain with clear roles and responsibilities of stakeholders. A representative of the Dutch seed tuber project joined the workshop in Kenya and showed great enthusiasm about the potentials of hybrid potato, hereby demonstrating the importance of exploring different systems in the potato chain.

Regional approach

Potato is an important food and cash crop in East Africa. The countries visited together comprise the second largest potato growing area in the world. The potato production in East Africa countries takes place in the highlands between 1200 to 3000 m.a.s.l, whereby two growing seasons are carried out and the production system is characterized by small-scale farming. Despite the low yield in the region, improved technologies are required to ensure food security.

The region shares similar constraints which include lack of certified seeds at affordable price, lack of high yielding varieties, low soil fertility, availability of diseases and pests, little crop rotation practices, lack of storage facility, lack of the know-how in crop management & post harvesting technology and poor access to the credit facilities and market information. However, the magnitude of each constraint varies from one country to another. Moreover, small-scale farmers in the region usually lack cash and credits (due to high interest rates) and as a result, they opt for a low input - low output strategy because they do not have the capability to invest in inputs for next crops and to improve production.

Key success factors

- Availability of genetic materials for immediate testing and selection
- Availability of technical know-how in coordination, implementation, management, monitoring and follow up.
- Favorable indicators for economic growth in East Africa (4 to 5 % up to 2020)
- Potato is a high priority crop by the targeted countries (as food and cash crop)

- Two growing cycles per year can be implemented to accelerate breeding activities and thus limited need for long-term storage
- Existing of committed and interested partners (public and private sector) in the value chain to participate
- Region shares many similarities in major constraints and crop management
- Good climatic conditions for potato production
- several processing companies already in place (Kenya), demanding good quality potato raw materials
- Seed certification and quarantine organization in place to facilitate import of true seed and to enforce UPOV regulations with respect to breeders' rights (Kenya and Tanzania).
- Well-managed (large scale) farms are available for evaluation and selection of introduced F1 hybrid varieties
- Increased trend in the domestic potato consumption
- Existing of local knowledge that accumulated over the years in the region
- Availability of manpower and reasonable political stability and climate for foreign investments
- Good relationship between targeted countries and the Dutch government.

Available resources

Potential donors that are mentioned by the stakeholders include USAID, Clinton foundation, NUFFIC and IITA. In addition, KLARO will seek support from the minister of Agriculture to allocate special funds or identify interested donors whom can support the F1 hybrid technology. In addition, it has been recommended that additional subsidies should be explored by the Dutch ministry of economic affairs and foreign affairs.

Risk factors

Risk factors, their level and measures undertaken for intervention are summarized in Annex 4. The risk factors mentioned are related to introduction & Adoption of technology, agronomic practices climate change, crop management, marketing, seed distribution & marketing, availability of inputs, and credit facilities.

Conclusions and recommendations

National level

- In **Tanzania**, Green Valley Agro may become a preferred private partner. Still, much efforts are needed to build a stable organisation with the public institutes and authorities. This may take a while.
- The perspectives for hybrid potato in **Kenya** are promising as the experienced company Seed Co is a strong potential partner, the public sector has expressed to support hybrid potato breeding and next to small-scale farmers also larger farms are present, who may be the frontrunners for this innovation
- At this moment, **Ethiopia** is too risky to start R&D activities with hybrid potato due to the demonstrations and attacks of private companies, like Solagrow.
- The Nioka farm in **East DRC** is considered as an example for similar private experimental farms in other countries. Before the end of 2016, Solynta and Lake Albert Investment will design a business-and partnership plan
- **Uganda** is the first follower of the Nioka farm, whereby a similar farm will be established in Zombo. This activity can be settled as part of the Solynta – Lake Albert Investment cooperation.

- The business perspectives of hybrid potatoes in **Burundi and Rwanda** are less positive due to the very strong government domination. Lake Albert Investment has started meetings with officials to explore similar activities like in Nioka and Zombo, but it is expected that it will take more time before similar activities may start in these two countries

Regional level

- The East African region shares similar limitations in the potato food chain.
- Awareness and understanding has been enhanced on the high potential of F1 hybrid potato.
- All countries are elaborating on streamlining their legal procedures on seed shipments, certification and ownerships. These developments are still in progress and harmonisation across the borders may facilitate a regional approach
- Joint research efforts of the private and public sector are required to study the potential of hybrid potato
- CIP and Solynta may cooperate in research on climate smart potato. To this end a project plan may be settled and submitted to get CGIAR funding
- A regional programme can be formulated to support and connect the national initiatives on hybrid potatoes and to develop dedicated hybrid varieties for the East African countries based on the needs of the local market and attuned to the local climate condition: short days, high temperatures, short season.

Acknowledgement

The Food & Business Knowledge Platform is greatly acknowledged for the mental and financial support for the two visits to East Africa.

We would like to thank all the participants for their interest and open attitude that they have demonstrated during the discussion of the F1 Potato hybrid cultivars and also for taking their time meeting with us and participating in the Solynta workshop in the countries visited.

Our especial appreciation goes to Dr. Bert Rikken, Ms. Theresia Mcha, Ms. E.K. Kiamba, Dr. Anno Galema, Herman Fleer, Henk Peters, GertJan Becx, Dr. Jan Willem Nibbering, Eline van der Veer, Dr. Innocent Matabishi and Dr. Teddie Muffels for their excellent support that we received during our mission which made our stay very pleasant and effective.

We are also very grateful to the Tanzanian Agriculture Research Institute (ARI)–Uyole, Kenyan Agricultural Livestock Research organization (KALRO), the Ugandan National Agriculture Research organization (NARO) and The Rwanda Agriculture Board (RAB) for their interest and support received during our visit.

Exploring the Potential of Hybrid Potato Cultivars In East Africa

Members:

Pim Lindhout and Daniel Danial, Solynta,

Wageningen, The Netherlands

Period: June 26th to July 7th, 2016

Introduction

A new hybrid breeding technology is being developed to accelerate breeding activities and propagation of starting materials. This technology will enable breeders to develop new potato cultivars that are attuned to the needs of the local producers and markets, much more rapidly than the conventional breeding technology. In addition, the products are hybrid seeds, that can be produced at high quantities within one growing season and that are devoid of any pathogen. This technology has been developed by the Dutch SME Solynta that has been awarded as National Icon by the Dutch Government.

The importance of potato in the diet of people in East Africa (designated the Region) is increasing. It has a better nutrition value than other staple crops and resembles vegetables. Potato is a resource efficient crop and has potential to contribute to improve the nutrition value of the daily diet. Potato is mainly produced by subsistent farmers, who maintain part of their produced potato tubers as starting material for next season. As a consequence, these so-called seed tubers are often heavily infected by pathogens, like viruses, bacteria, fungi and oomycetes, *Phytophthora infestans* being the most devastating. These deteriorated seed tubers are the main cause of the low average yield of about 10 tons/ha. Alternatively, high quality seed tubers can be produced locally with tissue cultures as healthy starting materials. This requires a good infrastructure that is mainly absent. The Netherlands have started a programme on introducing healthy seed tubers from The Netherlands that may be helpful in improving the infrastructure.

The hybrid breeding technology offers several advantages for the potato seed sector in East Africa:

- Clean seeds

The products of hybrid breeding are clean true hybrid potato seeds. These are excellent starting materials for commercial potato production.

- Fast multiplication

The hybrid seeds can be produced at high volumes in one growing season. This circumvent the laborious and time consuming process of many rounds of vegetative reproduction of seed tubers.

- Improved logistics

Clean hybrid seeds can easily be transported and stored until the conditions are optimal to start with commercial production of potatoes

- Fast breeding

In each growing season new experimental hybrids can be tested at the local environments to select the optimal varieties that are attuned to the local needs. The selected new hybrids can be rapidly propagated and made available in large quantities immediately after it has become commercial.

- Improved technology in genetic improvement

As soon as a new hybrid variety is successfully commercialised, new traits can be introduced in the same variety via marker assisted selection. This will result in derivatives with new resistances or other desired traits.

- Dedicated breeding

Locally potato varieties from the farmers' fields can be used as starting material for a new hybrid breeding programme, resulting in even more adapted varieties and rapidly adopted by the producers. This active breeding programme, whereby the hybrid products are tested at various conditions in the Region, is instrumental to develop resilient cultivars that are tolerant to various environmental stresses, including those caused by climate changes.

The development and implementation of the hybrid potato varieties in East Africa is a double challenge: True hybrid potato varieties are not in the market yet and the potato sector in East Africa is still not well developed. So, this project is a contributing towards improving /optimizing the potato value chain whereby the development of hybrid varieties, the development of cropping systems

based on true hybrid seeds and the improvement of the logistics of in the potato sector is accompanied by ethical and socio-economic studies. This comprises Research on farmers' acceptance of hybrid seeds, on practices of farm saved seeds, protection of intellectual property, sharing value in the potato chain, food sovereignty, market access, etc.

This challenge can only be addressed if the activities are well embedded and supported by the local organisations in the Region, both in the private as well as in the public sector. To this end a mission is planned to identify the crucial key players in the potato network.

Objectives

The aim is to interact with the existing networks in the potato sector in East African countries in order to identify the most relevant partners to investigate the practical feasibility on the utilization of hybrid potato seeds to support the potato food-network in a resilient way (designated the Project)

Action plan

Two Solynta experts will visit five countries in the Region: Tanzania, Kenya, Rwanda, Uganda and Democratic Republic of Congo (DRC) as these are the important potato producing countries with growing potato markets. In addition, in Ethiopia (will be visited at later stage), Tanzania and the Uganda / Rwanda border region (East Congo) Dutch potato farmers have already shown their interest to join the Project, whereby the first potato plants of experimental hybrids are already growing in East Congo. These farmers may play an important role in developing cropping systems that optimally fit in the local farming systems, farmers' participation, demonstration trials and communication with the local stakeholders to disseminate the new potato cropping systems.

In each country the most important stakeholders of the potato food network will be invited to join workshops and some major players will be visited (see Annex 1).

The tentative programme will be shared with Dutch officials from the Ministry of Economic Affairs and from Foreign Affairs in The Hague, who are experienced in the region. The Dutch Embassies and Agricultural Councillors (Landbouwraden) will be involved in organising the visits and workshops and invitations to the participants.

Expected Results

This mission is a crucial step in the design of a practical feasibility study as mentioned in the objectives. As a preparation of this plan, already a Hackaton has been organised in The Netherlands, whereby 40 students and ten experts have brainstormed a full day on the Project. As a follow-up, three students' groups spend three months on desktop studies on the potato food networks, interviewed relevant experts in The Netherlands and in the Region and wrote proposals about the implementation of the Project. Contacts have also been made with social scientists from Rathenau Institute, Wageningen University and Groningen University to study the non-technical aspects of the implementation of hybrid potatoes.

All these activities have been used to describe a draft Project plan. This includes a description of the strategy, the potential partners and embedding in the national organisations in the Region and a detailed work plan for the first five years. This plan will be challenged during the mission, based on the results of the workshops, visits and seminars on hybrid potatoes.

Before, during and after the mission the following results will be achieved:

- A detailed description of the potato food networks in the Region
- A network database on the main stakeholders, that are active in the Region

- The potential candidates for participation in the Project. These may comprise private companies, national and international research centres and NGO's that have specific expertise for the Project.
- Increased awareness of the local and national stakeholders on the potentials of hybrid varieties for the Region
- Suggestions on the efficient use of local knowledge and lesson learned into the Project
- Suggestions about the usage of local genetic potato materials for the Project
- A database of potential funding agencies for supporting (parts of) the Project
- An interactive process with local and Dutch stakeholders to design a Project proposal
- A revised plan for the development and implementation of hybrid potatoes in the Region. This plan will include annexes on the desired local activities in the Region and on the development of well adapted potato varieties for the Region.

A report will be written on this mission, with emphasis on the specific similarities and differences of the various countries and sub-regions in the Region, including the key success factors, limitations, risk, potentials etc.

A paper will be written about the potential contribution of hybrid potato varieties on food security and the potential impact on the potato food sector in the Region.

After the Mission, the plan will be further articulated and finalised. The final plan will include a detailed description of Phase 1, covering the first five years, including the description of:

- The development of adjusted cropping systems based on hybrid potato seeds, both for commercial farmers as well as for subsistent farmers
- A breeding programme to develop adapted varieties for the region in three steps: hybrid breeding based on EU materials for a first launch, marker assisted selections to introduce relevant resistance genes to biotic and abiotic stresses and dedicated breeding with locally adapted potato materials to develop resilient hybrid cultivars
- A plan of capacity building for the partners within the project as well as for the interested farmers and farmers organisation who are interested to start with the new technologies
- A programme to study the impact of the hybrid potato system on various actors in the potato food network
- A dissemination plan of the results during the first phase via scientific publications, brochures, news bulletins, websites etc.

and a description of a commercial plan for the second phase (Year 6 – 10) describing

- the present and future potentials markets for the new potato products
- the development and commercialisation of innovative adapted hybrid varieties
- capacity building and dissemination of knowledge in the field of the new potato systems based on hybrid seeds

The expert team

The two experts are Pim Lindhout (PhD), breeder and geneticist with more than 30 years' experience in R&D in the public and private sector, founder of Solynta, developer of the hybrid potato breeding technology and head R&D Solynta. The other expert is Daniel Danial (PhD), with 18 years' experience as breeder and researcher in Kenya, coordinator of the Preduza breeding programme in the Andes and experienced in capacity building programmes. Both experts have cooperated in managing and implementing breeding programmes in developing countries. Detailed CVs of both experts are mentioned in Annex 4.

Annex 2a. Visit program of Solynta mission to Tanzania, Kenya, Uganda and Rwanda from June 26th to July 7th 2016.

Date	Activities
Sunday June 26 th	Amsterdam - Dar Es Salaam, Tanzania 10:15-21:55 KL 0567, Stay in Southern sun hotel in Dar Es Salaam
Monday, June 27 th	09:00 – 13:00 Workshop in Dar Es Salaam and hosted by the Netherlands Embassy Contact persons: Bert Rikken and Theresia Mcha 13:00- 14:00 Lunch Departure to Nairobi: KQ 485 , depart 17:30 and arrival 18:50 Stay in hotel Jacaranda
Tuesday June 28 th	09:00 – 13:00 Workshop in Nairobi, KENYA, hosted by the Netherlands Embassy Contact persons: Bert Rikken and E. K. Kiamba 13:00- 14:00 Lunch 14:00- 17:00 Meeting with Maarten van Ginkel, seed Co ltd.
Wednesday June 29 th	09:00- 10:30 Visits to o Kenya Agriculture Livestock and Research organization 10:30- 13:00 Visit to Tigoni Research Station and get familiar with the potato research activities and potato tuber seed multiplication. Contact Persons: Lusike Wasilwa and Moses Nyongese 13:00-14:00 Lunch 14:00- 17:00 Reporting
Thursday June 30 th	Depart to Entebbe with KQ 412, depart: 10:30 Arrival Entebbe at: 12:45 Stay in hotel Lake view hotel - Laico
Friday July 1 st	09:00- 13:00: Reporting
Saturday July 2 nd	09:00- 17:00 Reporting
Sunday July 3 rd	09:00- 14:00 Reporting 16:00- 21:00 Meeting with IITA representative and Herman Fleer
Monday July 4 th	Workshop in held in Entebbe, hosted by the Ugandan Ministry of Agriculture and organized by the Netherlands Embassy Contact Persons: Anno Galema and Herman Fleer
Tuesday July 5 th	Depart from Entebbe to Kigali Entebbe-Kigali: Rwanda Air, WB 423, depart 17:00 and arrives Kigali 17:00 Stay in Umubano hotel in Kigali
Wednesday July 6 th	09:00-13:00 Workshop in Kigali hosted by the Netherlands Embassy Contact persons: Teddie Muffels and Innocent Matabishi. Departure to Amsterdam: KL 535, Kigali –Entebbe-Amsterdam at 20:20
Thursday July 7 th	Arrival to Amsterdam at 06:55

Annex 2b. Visit program of Solynta mission to Ethiopia and Uganda from October 10th to 17th.

Date	Activities
Sunday October 10 th	Travel from The Netherlands to Zaveltem, Brussel and via Vienna to Addis Ababa. OS 356 departure at 20:00 from Brussels and OS 7151 at 23:50 from Vienna.
Monday, October 11 th	Arrival at 7.00 in Addis Ababa. Taxi to hotel Stay in Hilton Hotel Addis Ababa. 10 th Triennial Conference APA, "Growing wealth to Health" in Addis Ababa. Meeting with Eric de Vaan, Senselet. Meeting with Betselot Mesfin Admassau, Jan Willem Nibbering and Eline van der Veen, Embassy of the Kingdom of The Netherlands. Meeting with Merideth Bonierbale and Graham Thiele CIP, Peru
Tuesday October 12 th	10 th Triennial Conference APA, "Growing wealth to Health" in Addis Ababa. Presentation at APA meeting of Pim Lindhout on: "Hybrid potato for Africa" Presentation at WPC workshop by Michiel de Vries on: "Hybrids for Africa: first experience in DRC" Lunch with Sukhjit Sing Bhatti, Bhatto Agritech, India and Anton Haverkort, WUR advisor Meeting with Jan J. van der Haar, Solagrow Final talk with Graham Thiele, CIP, Peru Meeting with (Hapson Mushoriwas, Group Soybean & Legumes Programme Lead & Maarten van Ginkel, breeding advisor
Wednesday October 13 th	Lunch meeting with Amsalu Ayana, director ISSD Ethiopian Program Travel from Addis Ababa to Entebbe. ET 334 departure at 15:00. Taxi to and stay in Peniel Beach Hotel, Entebbe Meeting with Fred Masika, MSc student from Uganda
Thursday October 14 th	Travel from Entebbe to Arua. Eagle air departure 8:00; arrival 9:30 Stay in Hostel Lake Albert Foundation, Aruha Meeting with Simon K. Anguma, deputy vice president of Muni University, Arua Workshop on hybrid potato for the Lake District in East Africa, Aruha Dinner with Henk Peters
Friday October 15 th	Workshop on hybrid potato for the Lake District in East Africa, Aruha Visit to Abi Zardi, NARO, Aruha, hosted by Sadik Kassim and Moses Kiryowa. Dinner with Henk Peters, Lake Albert Foundation, Uganda and Jaap Blom IITA, meeting with Uganda Minister of Livestock.
Saturday October 16 th	Travel from Arua to Entebbe. Eagle Air departure 12:00 Travel from Entebbe to Brussels. SN 469. Departure at 20:40
Sunday October 17 th	Arrival in Brussels at 6.30 Travel from Brussel to the Netherlands by train. Departure 7.11

Annex 3. List of participants of workshops and other stakeholders

Location/Country	Name, position , address and email address
Dar Es Salaam / Tanzania	<ol style="list-style-type: none"> 1. Bert Rikken, Agricultural Counselor, Embassy of the Kingdom of the Netherlands, bert.rikken@minbuza.nl 2. Dr. Zacharias Malley, Zonal director, ARI-Uyole, Box 400, Mbeya, malley.zacharia@gmail.com 3. Mdili S. Katemani, Senior Agricultural Officer, Plant Health Services, Box 9071, Dar Es Salaam., dancateman@gmail.com 4. Theresia Mcha, Agricultural Officer, Netherlands Embassy, theresia.mcha@minbuza.nl 5. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 6. Daniel Danial, Consultant, Wageningen, The Netherlands, daniel.danial@solynta.com
Nairobi / Kenya	<ol style="list-style-type: none"> 1. Bert Rikken Agricultural Counselor, Embassy of the Kingdom of the Netherlands, bert.rikken@minbuza.nl 2. E.K Kiamba, Agricultural Officer, Embassy of the Kingdom of the Netherlands, ek.kiamba@minbuza.nl 3. Dr. Victoria E. Anjichi, Lecturer, school of Agriculture & biotechnology, University of Eldoret, Box 1125-30100, eldoret.vicanjichi@gmail.com 4. Dr. Moses Nyongesa, Potato researcher, Kenya Agricultural Livestock and Research Organization (KALRO), moses.nyongesa@kalro.org 5. Dr. Lusike Wasilwa, Director Crop System, Kenya Agricultural Livestock and Research Organization (KALRO), lusike.wasilwa@KALRO.org 6. Nancy Nganga, Potato researcher, socio-economist, KALO, Tigoni, Box 338-0107, Limuru, nancy.nganga@kalro.org 7. George Momanyi, Kenya Plant Health Inspectorate Service(KEPHIS), Box 49592-08000, gmomanyi@kephis.org 8. Simeon Komon, Kephis, Has, Box 49592-08100, NBO, skomen@kephis.org 9. Willem Dolleman, Agrico East Africa, managing director, Box 63249, NBO, willem.dolleman@agrico.co.ke 10. Maarten van Ginkel, Agri seed company Ltd. Box 616, 0062Nairobi, Kenya, maarten@agriseed.co.ke 11. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 12. Daniel Danial, Consultant, Wageningen, The Netherlands, daniel.danial@solynta.com
Entebbe / Uganda	<ol style="list-style-type: none"> 1. Dr.Timothy Kakembo, Legal officer, P.O. Box 295, Entebbe, National Agriculture Research Organization (NARO), tkakembo@naro.go.ug 2. Dr. Jaap Blom, IITA, PASIC project manager, IITA, Naguru, Kamapla, J.Blom@cgiar.org 3. Dr. Alex Barekye, Director Kachwekano ZARDI, Zonal Agricultural and Research Development Institute, alexbarekye@yahoo.com 4. Dr. Sadik Kassim, Director of Crop Resources, Abi ZARDI, P.O. Box 219, Arua, sdkassim@gmail.com 5. Dr. Rober Kajaobe, Director RWEBITABA, ZARDI, P.O. box 96, Fortportal, rkajobe@gmail.com 6. Dr. Piet van Asten, IITA, Country representative, Po. O. Box 7878, Kampala, p.vanasten@cgiar.org 7. Leocardia Nabwive, IITA-PASIC-ZIP, Facilitator, Po. Box 7878, Kampala, nleocardia@mail.com

	<ol style="list-style-type: none"> 8. Dr. Charles K Byarucmba, Director of clean and quality seed potato production project, Kabela district, Charlesbyarugalz@gmail.com 9. Dr. Muhangi k.Ambrose , committee member Uganda National seed potato producers association, P.O. Box 329, Kabele, muhangik@yahoo.com 10. Dr. Patrick Rubaihayo, Emertis Professor makerere university, P.O. Box 7062, Kampala, prubaihayo@gmail.com 11. Prof. Christine Dranzon, Vice Chancellor Muni University, P.O. Box 725, Arua, cdranzoa@yahoo.com 12. David Slane, Chief of party, IFDC, Uganda, P.O. Box 75391-Kampala, dslane@ifdc.org 13. Patrick Oyie, Deputy chief of party, ISSD Uganda, Studio House, deop@issduganda.org 14. Rony oyoyed, director agromax farm. Luteete Gayaza Rd, ronyo@agromaxug.com 15. Anno Galema, First Secr. Embassy of the Kingdom of the Netherlands, Kampala, anno.galema@minbuza.nl 16. Dr. Herman Fleer, Director Ecopolis Europa, PO.Box 138, 6700 NC, Nederland, mail@ecopolis.nl 17. Dr. Lawrence Qwere, Director Buginyanya ZARDI, P.O. Box 1356, Mbale, labowere@gmail.com 18. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 19. Daniel Danial, Consultant, Wageningen, The Netherlands, daniel.danial@solynta.com
Kigali / Rwanda	<ol style="list-style-type: none"> 1. Teddie Muffels, Agric. Counselor, Netherlands Embassy, Kigali, teddie.muffels@minbuza.nl 2. Dr. Jean Claude Izamuhaye, Head of northern agric. Zone, Rwanda Agriculture Board (RAB), P.O. Box 73, jeanclaude.izamuhaye@rab.gov.rw 3. Dr. Ntizo Senkesha, Researcher RAB, Musante, senkesha@yahoo.fr 4. Jean Paul Ndagijimana, Country director, Clinton Foundation, C-D-I, jndagijimana@clintonfoundion.org 5. Jean Claude Nshimiyimana, Seed system officer, International Potato Centre (CIP), Rwanda, J.njhimiyimana@cgiar.org 6. Frqr Hageuimama Tritri, Rector INES, Ruhurperi, hageuuhov@yahoo.com 7. Innocent Matabishi, Agriculture policy officer, EKN, innocent.matabishi@minbuza.nl 8. Niyonzima Jean Pierre, Lecturer and Head of Department, UR, CAVM, nijpeter@gamial.com 9. Johan Veenkamp, IFCD, Country representative, jveenkamp@ifdc.org 10. Pieter Dout, Head of Dev Cooperation, Netherlands Embassy, Pieter.dout@minbuza.nl 11. Patrice Orugenzi, Assistant lecturer, potato team, UL, CAVN, patem03@gmail.com 12. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 13. Daniel Danial, Consultant, Wageningen, The Netherlands, daniel.danial@solynta.com
Addis Ababa, Ethiopia	<ol style="list-style-type: none"> 1. Gertjan A. Becx, Project Manager, Ethiopia Netherlands Trade for Agricultural Growth (ENTAG) / BENEFIT, Addis Ababa, Ethiopia. gertjan.becx@gmail.com

	<ol style="list-style-type: none"> 2. Jan Willem Nibbering, Food Security, Embassy if the Kingdom of The Netherlands, Lideta K.K., Kebele02/03, H. No 001, Old Airport Zone 1, P.O. Box 1241, Addis Ababa, Ethiopia. Jw.nibbering@minbuza.nl 3. Eline van der Veen, Embassy if the Kingdom of The Netherlands, Lideta K.K., Kebele02/03, H. No 001, Old Airport Zone 1, P.O. Box 1241, Addis Ababa, Ethiopia. Eline.veen@minbuza.nl 4. Betselot Mesfia Admassu, Agricultural Policy Officer, Embassy if the Kingdom of The Netherlands, Lideta K.K., Kebele02/03, H. No 001, Old Airport Zone 1, P.O. Box 1241, Addis Ababa, Ethiopia. Betselot.admassu@minbuza.nl 5. Eric de Vaan, General Manager Senselet Food Processing PLC, San Building, 5th Floor, Bistrate Gabriel Road, EPHARM, Addis Ababa. gm@senseletfoodprocessing.com 6. Merideth Bonierbale, Leader of Genetics, Genomics and Crop Improvement, CIP, Direccion Postal: Apartado 1558, Lima 12, Peru. m.bonierbale@cgiar.org 7. Graham Thiele CIP, director CGIAR Research Program on Roots, Tubers and Bananas, Direccion Postal: Apartado 1558, Lima 12, Peru. G.thiele@cgiar.org 8. Andrew Kinggundu, National Agricultural Research Organisation (NARO), Plot 3, Lugard Avenue, P.O. Box 295, Entebbe, Uganda akiggundi@gmail.com 9. Sukhjit Sing Bhatti, Proprietor Bhatto Agritech, Village Alipur, P.O. Mithapur, Distt. Jalandhar – 144022, Punjab, India. sukhjit@bhattifarms.com. 10. Anton J. Haverkort, Plant Research International, WUR, P.O. Box 61, 6700AA Wageningen, The Netherlands.Haverkort, 11. Jan J. van der Haar, CEO Cropgrow Crop Production PLC / Solagrow, P.O. Box 1503 (Debre Zeit) Egdu 9, Hidi, Oromia, Ethiopia. cropgrowplc@gmail.com 12. Hapsonj Mushoriwas, Group Soybean & Legumes Programme Lead, Seed Co Zimbabwe (Private) Limited, Rattray Arnold Research Station, P.O Box CH 142, Chisipite, Harare, Zimbabwe, hapson.mushoriwa@seedcogroup.com 13. Maarten van Ginkel, breeding consultant, Agri Seed Co Ltd, Mombasa Road, Next to MRM, Postal address: P.O. Box 616, 00621, Nairobi, Kenya, maarten@agriseed.co.ke 14. Amsalu Ayana, Haramaya University, director Integrated Seed Sector Development (ISSD) Ethiopia Program. Meskel Flower Street, Arsho Building, 5th Floor, Addis Ababa. Aga.armsaluayana@gmail.com 15. Wachira Kaguongo, CEO National Potato Council of Kenya. KALRO-Kabete, Waiyaka Way PO box 29982-00100. Nairobi, Kenya. nkaguono@npck.org 16. Suresh Patel. Managing Director. Genetics Technologies International Ltd. PO box 47430 Nairobi, Kenya. kae@africaonline.co.ke 17. James Hutchings. Stokman Roses Kenya PO box 2029-20117 Naivasha, Kenya james@srk.co.ke 18. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 19. Michiel de Vries, lead Agronomy Solynta, Wageningen, The Netherlands. Michiel.devries@solynta.com
Arua, Uganda	<ol style="list-style-type: none"> 1. Fred Mwayo Musika, MsC student Nairobi, Uganda, masikafred2012@gmail.com 2. Dr. Sadik Kassim, Director of Crop Resources, Abi Zonal Agricultural Research and Development Institute (Abi ZARDI), P.O. Box 219, Arua, Uganda, sdkassim@gmail.com 3. Kiryowa Moses, research officer, NARO- Abizardi, Uganda, m.kiryowa@gmail.com 4. Thoiceca Pascal, agronomist FLA / NIOKA, DRC 5. Nyende Siraj, seed inspector, Ministry of Agriculture, Animal Industry and Fisheries, (MAAIF), Uganda, sironug@yahoo.com

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| | <ol style="list-style-type: none"> 6. Ir. Ulangi Uma, agricultural officer, Inspecteur Provincial à l'Agriculture, Pêche et Elevage (IPAPPEL) MAHAGI, DRC, ulongitheophile@gmail.com 7. Tamile Atobi, agronomist, Institut Supérieur d'Études Agronomiques et Vétérinaires d'Aru (ISEAV/ARU) foundation, DRC, Bauclaun.Tamile@fr 8. Katunga Musale, prof. Institut National pour l'Étude et la Recherche Agronomiques (INERA), DRC, stylonia@gmail.com 9. Niyonzima Pierre, potato programme leader, Institut des Sciences Agronomique du Burundi (ISABU), pierreniyonzima@gmail.com 10. Kerunega George, agricultural officer Zombo, Uganda, Kerunegageorge2014@gmail.com 11. Alfred Alumai, agriculture research director, Muni University, Uganda, a.alumai@muni.ac.ug 12. Nijimbere Severin, deputy dean UB-FABI/ Burundi, niseverin@yahoo.fr 13. Gahungu Fidele, director general Office National de Contrôle et de Certification des Semences (ONCCS), Burundi, gahungufid@yahoo.fr 14. Namugga Prossy, research officer, NARO-KAZARDI, Uganda, namugguke@gmail.com 15. Leocardia Nabwire, consultant IITA, Uganda, nleocardia@gmail.com 16. Beatrice Sakwah, consultant, IITA, Uganda, b.sakwah@cgiar.org 17. Dan Abudu, assistant lecturer, Muni University, Uganda, d.abudu@muni.ac.ug 18. Simon K. Anguma, DVC-AA Muni University, Uganda, s.anguma@muni.ac.ug 19. Dr. Jaap Blom, IITA, PASIC project manager, IITA, Naguru, Kampala, Uganda, j.blom@cgiar.org 20. Pim Lindhout, R&D director Solynta, Wageningen, The Netherlands. pim.lindhout@solynta.com 21. Michiel de Vries, lead Agronomy Solynta, Wageningen, The Netherlands. Michiel.devries@solynta.com 22. Henk Peters, agronomist Lake Albert Foundation, Uganda, hommelhof@gmail.com |
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Annex 4. Risk factors and measures for intervention

Risk factors & level with proposed measures of intervention for introducing potato hybrid cultivars in East and Central Africa by Solynta.

Risk factors	Risk level	Measures for intervention
Introduced technology among local partners and growers is not adopted and or poorly accepted. Growers are not familiar with the introduced technology	Moderate	Demonstration trails are organised and awareness is created for cost benefit and impact. Provide training and technical backstopping at all level. Participatory approaches to ensure acceptance and adoption of technology within a short period of time.
Poor quality of seedling or late delivery	Moderate	Improved Seed raising technology is developed and tested for viability and effectiveness. Outsourcing for seedling production and adequate planning ahead of time
Change in climate conditions (adverse biotic and abiotic stress factors)	Moderate	Use climate data, growers' knowledge. Introducing and prompting the use of tolerant cultivars to drought and resistant to pests and diseases.
Appearance of new strains of pathogens e.g. viruses	Moderate	IPM measures are undertaken and Support of plant pathology for identification of strains
Change in marketing priorities	Moderate	Market transparency and information are obtained
Lack of inputs and materials	Moderate	Inventory of availability, delivering and pricing is studied a head of time and purchased. Linking with private sectors.
Poor access of seeds to growers	Moderate	Linking with private sectors for efficient seed supplying system and distribution at affordable prices.
Lack or shortage of credit facilities?	Moderate	Identify sources of financing with local banks and linking with donors.
Deterioration of the produce after harvesting	Moderate	Long shelf cultivars and improve post harvesting technology and storage facilities
Lack of security in conflicts zones	Moderate	Avoid risky zones??

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