Potato prospects for Ethiopia: on the road to value addition

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Table of contents

page

Summary

The agricultural counsellor (Geert Westenbrink until mid-2012 since then Hans van de Heuvel) at the Royal Netherlands Embassy at Addis Ababa requested his ministry to fund a 1 year – 2012- project within the framework of "Policy Support Cluster International", the so-called BOCI program. The order for Wageningen University and Research Center (WUR) was to identify constraints and opportunities for value addition in the Ethiopian potato supply chain. The bulk of potatoes in Ethiopia is consumed by the producer and his family or traded to the cities, especially to Addis Ababa. Some very minor cottage industry exist to make crisps but hardly any value (about 50 % between farm gate and consumer in Addis) is added between the grower who receives Birr 3 and the consumer paying Birr 4.5 per kg. The objectives of the study to be carried out were:

- Is there consumer interest in high end products such as washed and packed fresh potatoes for the supermarkets and crisps and chips (frozen French fries).
- Are there interested parties to manufacture such products and what are the specifications of the potatoes to meet the demand.
- Can growers deliver the supply reliably and consistently throughout the year.
- How should the supply chain be organized.
- Can an international Public – Private – Partnership be set up within the framework of the newly established Topsector Policy in The Netherlands.

The Wageningen UR groups Plant Sciences (Plant Research International –PRI - and Applied Plant Research – PPO) and Social Sciences (Institute of Agricultural Economics – LEI) formed a team (the alphabetically listed authors of this report) to answer the questions above. To this end several missions were carried out in 2012 to Ethiopia to interact with all stakeholders and the following actions took place:

- Review of literature and internet data
- Fact finding field visits to observe crops, stores and management practices
- Discussions with policy makers and researchers of national and international organizations
- Interviews with growers, traders, middlemen, wholesalers, retailers, hotels and restaurants
- Discussions with Netherlands industries (machinery and frozen fries manufacturers)
- The writing of a Topsector proposal (jointly for India and Ethiopia) and a business plan for a French fry factory
- A one day conference in December involving all stakeholders in the Ethiopian potato industry in Addis Ababa
- A three day potato course in December in Addis Ababa
- The writing of the present report with all findings and conclusions.

The results are shown in this report.
The highlights are that there are very good prospects for value addition with increasing numbers of urban consumers willing to diversify their potato consumption pattern including branded and packed fresh potatoes in (super)markets, chips and crisps. The environment in Ethiopia is very suitable allowing year round production and growers can meet the specifications if well instructed, guided and organized.
The BOCI project was funded by the Netherlands Ministry of Economic Affairs and an investor was identified wanting to operate a frozen French fries (chips) factory as of 2014.
Regarding crucial aspects of the supply of potatoes to the high end markets the Conference in three themes each - 1. potato seed, 2. potato production and 3. processing - mentioned five challenges and their avenues for improvement to be followed up.

1 Introduction

1.1 General

Potato is the fastest growing food crop in Sub-Saharan Africa (SSA) with total production in some countries more than doubled during the last 15 years. This is similar to the developments in Asia (China and India) where area and yield increased strongly. Furthermore potatoes produce considerably more energy and protein than cereals. One of the reasons is its high harvests index: proportion of all dry matter produced that is edible as no straw is made. An added advantage of the crop is that long before crop maturity, tubers can be eaten. Potato yields in SSA (South Africa excluded) are below 10 t/ha while the attainable yields with good crop management are well above 30 t/ha if supplied with good seed, fertilizers and crop protectants. As the Ethiopian population grows rapidly, potatoes offer opportunities as one of their main staple foods. The Netherlands Ministries of Foreign Affairs-International Cooperation (OS) and Economic Affairs, Agriculture and Innovation (EL&I) have expressed their interest on food security issues in their African target countries. To that end, the agricultural counsellor in Ethiopia took the initiative to put potatoes on the agenda to identify opportunities for food security and Dutch businesses.

The Netherlands is a renowned 'potato' country. The Netherlands is indisputably leading in seed potatoes: its share in total world export value is about 60 %. Furthermore, it is the third exporter (11 % of world total) of fresh edible potatoes after France and Germany. In addition, the Netherlands is the largest European producer of potato products such as French fries and chips (crisps). This importance is reflected in the leading position regarding innovative knowledge available at its research institutes (Wageningen UR) and its (private) potato breeding and processing companies.

The study shows to enhance the capacity of the Ethiopian potato sector and further how to develop potato supply chains for various markets including (super)markets, processing industry and potential export. Increasing the economic potential is the ultimate goal.
The structure of the report follows the demand driven links of the chains (consumption, marketing channels, storage, logistics, processing, production of seed and table potatoes, supply of inputs, the institutional environment). The aim of the efforts in Ethiopia is to support the policymakers in the Ethiopian and Dutch government and their representatives in their decision making by identifying business opportunities that enhance the food security in Ethiopia and by identifying Private-Public-Partnership (PPP) business linkages between companies in the target countries and the Netherlands. PPP aims at improving agricultural commodity supply chains amongst others by providing varieties with higher yields and that are less vulnerable to diseases and pests, increasing the supply of food, reducing losses and value addition by enhancing logistics, processing.

More specifically the overall question is: *how can potato production be increased and how does it - in food insecure Ethiopia - contribute to higher levels of food availability and security than other crops and/or does potato production improve the welfare of the society by export earnings ?*

Note that the questions address separately several supply chains: seed potato supply to domestic table potato growers and export markets and table potato supply to domestic consumers and export markets.

1.2 Country profile

Under Ethiopia's constitution, the state owns all land and provides long-term leases to the tenants. Ethiopia has abundant agricultural land, but a large part is not (yet) in cultivation. Water shortages are common, though irrigation (flood and drip) is on the increase. Despite Ethiopia's association with severe drought in moisture deficit region resulting in food insecurity, the country is well endowed with mostly unused water resources (springs and rivers). For example, more than 85 % of the river Nile originates from Ethiopia. Nevertheless, Ethiopia is facing natural and environmental degradation, especially in the highlands. Forests are diminishing and soil fertility is declining. In the lowlands and midlands (between 500 and 2000 meters altitude) still much fertile and uncultivated land is available for agricultural investment. As potatoes are bulky, transport infrastructure is important. Ethiopia has a fair main road infrastructure,

Table 1. **Key figures of Ethiopia in 2010.**

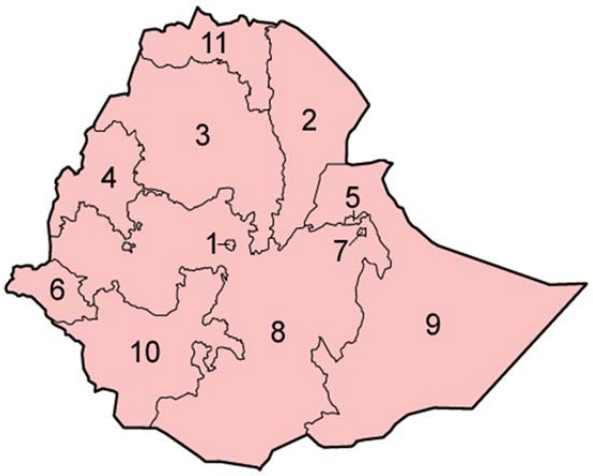
Population	83 million.
Annual growth rate	2.4 %
Capital 2009*	Addis Ababa, 2.9 million inhabitants
Land Area	100 million ha, 27 times the Netherlands.
Agricultural land 2009	35 million ha, annual growth 1.3%. 35% of land area in use as agricultural land
Freshwater resources	The annual freshwater withdrawal is 5% of the renewable resources. Agricultural is the major consumer (93%)
GDP (current USD)	30 USD billion
GDP-growth	10.1 % in 2010, 8.8 % in 2009, 11 % in 2006 to 2008
Origin value added (2009)*	Agriculture 48 %, industry 14 % and services 38 % Labour force Agriculture 85 %, industry 5 % and services 10 %
GDP / capita (current USD)	358; Sudan 1.425; Kenya 775; Egypt 2,698; European Area 36.618
Currency (13/02/2012)	Ethiopian Birr (ETB); 1€ = 22.8ETB; 1USD = 17.3ETB Literacy 2008
Life expectancy at birth	58 years
Inflation	Consumer price 8 %, average 2006-2010 18 %
Main exports*	Coffee, qat, gold, leather products, live animals, oilseeds
Export destinations 2010*	China 13.9 %, Germany 10.5 %, Belgium 7.5 %, Saudi Arabia 7.1 %, US 6.8 %, Sudan 4.6 % (2010)
Main imports 2010 from*	China 15.1 %, US 9.5 %, Saudi Arabia 8.8 %
Ethiopian calendar 2004	Gregorian Calendar September 2011 to August 2012

Source: World Development Indicators (World Bank) and * The World fact book (CIA)

Ethiopian calendar 2004 Gregorian Calendar September 2011 to August 2012

Although with 40 km per 100,000 ha, 14 % of the road is paved. The main roads converge on Addis Ababa. Currently the roads from Addis Ababa to Djibouti, from Bahir Dar and Hawassa to Addis Ababa, from Gonder to Humera and from Bale Mountains (Robe/Goba) to Hawassa are in perfect shape. To the West the road to Gambella is already paved and a new road linking Mekelle to Djibouti is almost finished. The government aims at increasing the road density to 124 km per 100,000 ha in 2014/1015 as described in the Growth and Transformation Plan (MoFED, 2010). The bulk (95 %) of Ethiopia's international trade is handled by Djibouti. Though, Djibouti remains the most important and largest port, Port-Sudan (Sudan) and Berbera (Somalia) rise in importance. Now, a new dry port for cargo transhipment is finalized in Mojo (80 km East of Addis on the main road to Djibouti), where containers can be checked and cleared for Djibouti port.

Figure 1. **Regions in Ethiopia.**



Region	
1	*Addis Ababa* (city)
2	*Afar*
3	*Amhara*
4	*Benishangul-Gumaz*
5	*Dire Dawa* (city)
6	*Gambela*
7	*Harari*
8	*Oromia*
9	*Somali*
10	Southern Nations, Nationalities and People's Region (SNNPR)
11	*Tigray*

In addition, storage facilities are established to relieve the congested port of Djibouti. A second dry port is planned for Semera Town (Afar), 580 km Northeast of Addis Ababa, close to the border with Djibouti. Of the export 60 to 80 % are food products, on the import side 10 to 20 % is food. In 2010, the costs to export a container are US $ 1 760, below the level of e.g. Kenya or Sudan. In addition the costs to import a container are with US $ 2 660 above the level of Kenya but below the level of Sudan.

Agricultural is Ethiopia's most important sector in the economy. As is shown in table 1.1 over 80 % of the population depends on agriculture, it contributes the largest part to the Gross Domestic Production (GDP) and contributes 9 0% to the total exports. A major challenge is to feed the Ethiopian people. The annual population growth of 2.4 % will result in a population of 100 million people by 2020: an increase of 20 % in 8 years' time. Together with continued economic growth, this will steer the demand for more luxury and processed food. The Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) aims to "sustainably increase rural incomes and national food security. This objective embodies the concepts of producing more, selling more, nurturing the environment, eliminating hunger and protecting the vulnerable against shocks; all of which are embodied in various national policy instruments". Increasing production, productivity and commercialisation are within the focal objectives (MoFED and MoRAD, 2010). If the agricultural production increases substantially, the export earnings, foreign currency source will increase too.

1.3 Quick scan of the Ethiopian potato production

In Ethiopia, the main production season for potato, at altitudes higher than about 2,500 m.a.s.l. is June to September (*Meher* in Amharic). The off-season production slot for Ethiopia at higher elevations is April to August (*Belg* in Amharic). However, one should bear in mind that nowadays the main production season for ware potato represents only 22 % (34,000 ha), while the off season production is around 128,000 ha. The reason for a gradual shift from Meher to Belg is the fact that the late blight pressure is increasing and farmers experience less risk with cultivation during the "small" rains combined with irrigation. During the main season, risks are high. The average potato production throughout Ethiopia is 8 – 10 t/ha. This is a relatively low average, especially when considering the potential of Ethiopia, with its favourable climate at higher elevations, soils and irrigation potential. The main production constraints are related to the narrow genetic basis of the varieties and the poor seed quality. In addition, the disease pressure / susceptibility is increasing and management capacity of the farmers is poor. High land potato production can be combined with barley and linseed, where potato for those regions is an interesting cash crop but also provides a staple with relatively good nutrition value, making it a crucial crop for food- and nutrition security for the highlands.

The South Central Rift Valley of Ethiopia, especially around Lake Koka and Lake Ziway, is an important production pocket for vegetables serving the urban markets of Addis and cities like Nazareth and Awassa. In addition, considerable volumes of vegetables are traded to more distant regions of Ethiopia and exported to Djibouti. In the main rain-fed season, from May to September, farmers usually grow staple crops such as teff, wheat,

sorghum and maize, but during the rest of the year the region is renowned for irrigated vegetable production, predominantly onion and tomato. Because of the altitude (>1,800 -<2,200 m.a.s.l) this region is suitable for a potato winter crop. The soils and the availability of irrigation provide suitable conditions for potato. Potato however, is a relatively new crop to the Meki / Ziway region but farmers increasingly cultivate a winter crop potato, planting around December under furrow irrigation and harvesting their produce as the first young potato for the markets as of March. This production window fits well in their crop rotation with field crops and onion. In that particular period of the year, there is only limited occurrence of the late blight disease, which makes this potato winter crop an interesting alternative to onion and tomato. The cultivation risks are limited while the price opportunities in the market are there. The current farming practice however, leaves room for improvement. Moreover, this production window for potato provides additional added value opportunities for young, washed and graded fresh delivery to Addis. Reportedly, these new potatoes can be sold for double the price compared to older ware potatoes from (soil) storage. In Meki and Ziway and in comparable regions, potato production can only be successful in the period December – March, because at these altitudes, the rest of year becomes too hot and too wet for potato production.

The regions Amahara, Oromia and SNNP in the South of the country are the main potato producing areas in the country but the Gayint region 500 km North of Addis Ababa at altitudes above 3,000 m.a.s.l. also seems to qualify well. Much of the potato arriving from outside Addis arrive at the wholesale market in the Piazza district of the city. Here potatoes arrive early morning in trucks loaded with bags (white plastic/nylon mashed bags). The bags are opened, the potatoes heaped and the content sold to consumers and small scale retailers who sell on the street sides and stalls. The “variety” was Shashemene in two types pink eyed (Carah) and white (various). One was determined to be “Bokoji but not clear if this is a site or a variety. Lots of insect damage and pressure bruising. Retail price was Birr 6 per kg, farm gate close to Birr 3 per kg. A labourer’s daily wage is about Birr 35 - 45 . Processed potatoes are restaurant made and a look in the kitchen of small roadside restaurant showed two ladies peeling and slicing, neatly dressed in white clothes and the slicer/kook with a kook’s hat. The frying equipment consisted of two oil baths each with a metal net. Quite neat and the fries were well presented.

A French frying device being operated along the road.

North of Ambo the variety Jalena was harvested mid-February about 5 months after crop maturity. This crop was planted in June 2011, was mature 4 months later and kept in the soil since then (about 5 months) and about to sprout but in rather good condition still. Harvest takes place by an ox drawn plough that drives two or three times in perpendicular directions whereupon the tubers are handpicked in baskets and delivered to 60-90 kg bags. Plants were in rows but each plant individually hilled. At planting two small or one large tuber per hill. Yields are about 10 tons per hectare. Fertilization 100 kg DAP (including a bit urea) per hectare. “Agro” Dithane or Ridomil is applied about three times per season. In September at peak harvest time the grower fetches Birr 1.8 per kg, five months later it is Birr 2.5 (ex-field) for variety Menegasha that is high yielding (late maturing), Jalena and Gudene are earlier maturing and have better table qualities. At Ambo roadside French fries and chips are prepared by several cooks.


Potato planting time.

Solagrow develops a new farm of a few hundred hectare ploughed grassland at Wenchi. Flat, intended for irrigated dry season farming i.e. now planting (February May) crop of Dutch varieties Red Scarlet, Ceasar and Markies. Supplied with 165 kg DAP and 195 kg urea for seed potatoes applied only once in planting furrow for ware potatoes split (45 kg urea applied during growth). Top 4 problems: seed potatoes (diseases spread by them), soil preparation, N-fertilization, variety availability. In rainy season 10 t/ha is normal for Ethiopian varieties, the HZPC varieties then do not perform due to blight resistance (probably too early maturing) The Dutch varieties are too sensitive and chemical control is not effective with heavy rains rinsing away the fungicides. Solagrow also grows Gudene, Jalene and Balete seed for rainy season crop for other growers than Solagrow. These varieties originate from Holeta and represent 20 % of Solagrow crop. Trying late blight resistant variety Sarpo Mira in rainy season may be an option.

In October 2011 some downloadable reports of studies carried out such as the "Potato value chain analysis and development in Ethiopia" and the "Roadmap for investment in the seed potato value chain in eastern Africa" both commissioned by USAID and carried out under the auspices of the International Potato Center (CIP). Below follows a summary of these reports as far as relevant for the aim of this report: Implementing high end urban potato marketing in Ethiopia. Where data are shown it concerns average values over areas, years and growers to obtain impression of the value chain without going into time and location specifics.

Ethiopia officially produces potato on 160 000 ha with an average yield of 10 t/ha so the national production is 1.6 million ton. Assuming that 1.5 t/ha is used as seed (15% of the production) and another 15 % is lost in storage and transport that 1.12 million ton is actually consumed by a population of 85 million. This means that the average Ethiopian consumes 13 kg potato per year or 250 g per week, or two modest portions per week. Holeta researcher Gebremedin, however, concludes from a survey that annual production area is about 250 000 ha with an average yield of 8 t (2 million ton national production of which 70% consumed) leading to a consumption of 316 g/week.
On experimental fields using improved seed, varieties and management yields varying between 19 and 46 t/ha have been reported. The main potato season is during the short rainy season planting in February and harvest in June, a second planting season is during the intense rainy season (July-August) and marketed as of September when part of the crop may be 'stored' in the soil for many months. To avoid the glut some growers plant and or harvest earlier or later spreading out the flow to the market. Farm gate, wholesale and retail prices fluctuate accordingly and typically are Birr 2, 3 and 4 in August and 3, 4.5 and 6 during the low supply season. Supermarket (washed, 1 kg plastic bag may go as high as Birr 10 per kg). A distinct off season production periods exists: a winter crop during frost free low lying areas Rift Valley (1 600 m.a.s.l.) from December through to March and a minor rainy season crop in the South from January through to April.

The aim of this chapter is to gather arguments in favour of and to foster interest in high end urban potato marketing in Ethiopia. Current production is in balance with consumption and is likely to increase gradually if seed systems increase the delivery of healthy seed and if inputs become available and their use efficiency assured. New impetus is expected from new paradigms in the current production system:

- The introduction of new high quality multi and single purpose varieties grown outside the rainy season

- The establishment of a supply chain of high quality table potatoes to high end super markets in urban areas
- The introduction of a pilot processing plant and distribution unit of chilled French fries from purposely grown potatoes for hotels, restaurants and supermarkets in urban areas. Optional: crisps ?

Table 2. **Structure and performance of potato growers (Meher season).**

Region	Year	Holdings	Area	Production	Yield/ha	Area/ holding	Production/ holding
		(Number)	(Ha)	(Ton)	(Kg)	(Ha)	(Kg)
Tigray	2010/2011	23,894		5,453			228
	2005/2006	17,339	403	4,240	10,528	0.02	245
Amhara	2010/2011	475,341	20,547	180,706	8,795	0.04	380
	2005/2006	457,974	26,512	181,583	6,849	0.06	396
Oromia	2010/2011	320,198	24,343	185,084	7,603	0.08	578
	2005/2006	336,323	24,924	187,478	7,522	0.07	557
SNNPR	2010/2011	307,812	8,069	72,701	9,010	0.03	236
	2005/2006	285,332	9,658	74,600	7,724	0.03	261
Not specified	2010/2011	5,772	1,048	3,390			
	2005/2006	7,463	315	2,095	6,646	0.04	281
Ethiopia	2010/2011	1,133,017	54,007	447,333	8,283	0.05	395
	2005/2006	1,104,431	61,812	449,996	7,280	0.06	407

Over 1 million Ethiopian holdings are producing potatoes: about 10 % of all crop producers. Over 80 % of the production area can be found in Amhara and Oromia region and around 15 % in SNNPR. The average scale per holding is low: the area is around 500 m^2 and the production is around 400 kg per holding.

In contrast to the FAO-statistics indicating yields above 10 ton/ha in 2009 and 2010, the yields derived from the Ethiopian Central Statistical Agency are below 10 ton/ha. The latter is also in line with the findings of (Abay and Ayalew and Tesfaye and Dejene, 2011): yield is below 10 t/ha, 47.5 % for household consumption and 15.6 % as cash crop.

2 Weather data and calculated attainable yields

2.1 Agronomic conditions, Climate, soil, water

Ethiopia has several agro-ecological zones due to a wide range of altitudes. Ethiopia distinguishes 6 main zones based on elevation (IFPRI/CSA, 2006):

1. Bereha. Hot lowlands of less than 500 meters above sea level. In the arid east, crop production is very limited. In the humid west, mixed root crops and maize are grown.
2. Kolla. Lowlands between 500 and 1,500 meters. Predominant crops are sorghum, finger millet, sesame, cowpeas, and groundnuts.
3. Woina Dega. Highlands between 1,500 and 2,300 meters. Predominant crops here are wheat, teff, barley, maize, sorghum, and chickpeas.
4. Dega. Highlands between 2,300 and 3,200 meters. Predominant crops here are barley, wheat, oilseeds and pulses.
5. Wurch. Highlands between 3,200 and 3,700 meters. Barley is common here.
6. Kur. Highland areas above 3,700 meters that are primarily used for grazing animals.

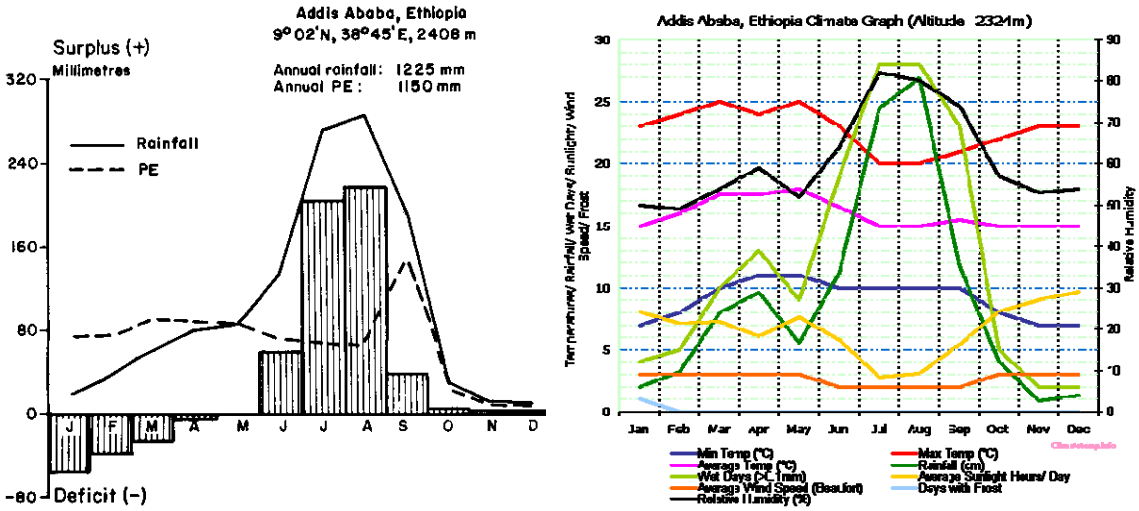
The altitude between 1,800 to 2,500m is suitable for seed and table potato growing and 70% of the Ethiopian agriculture land is located at that altitude (Emana and Nigussie, 2011). According to FAO this area is also suitable for potato growing (FAO, 2008).

Collecting the remaining potato tubers (near Shashemene).

Furthermore Ethiopia has two seasons depending on the rainfall. There is a long and heavy summer rain, from June-September (Meher season). In some areas it is followed by a hot, dry period and in others by short and moderate spring rains in March and April. The latter are known as the little rains or Belg. Crops in the main "Meher" season are between the months of Meskerm (September) and Yekatit (February). The Belg season crops are harvested in the months between March (Megabit) and August (Pagume). The "Meher" season accounts for 90% of the area and over 95% of the production quantity (CSA, 2011d). The Ethiopian Central Statistical Agency does not provide information on potatoes in their report on area and production in the Belg Season. However, Emana and Nigussie (2011) stated that the Belg season is also an important potato growing season. In the SNNPR and Shashemene area, the main production region is even in the Belg season, due to the low light blight infection and favourable market conditions (p 17).

A potato clamp for temporary storage in the field (near Shashemene).

Figure 2. **Precipitation deficit and weather data of Addis Ababa.**



Gildemacher et al. (2009) underlines the importance of the Belg and off-season periods for growing potatoes. In West Shewa (Oromia) and Awi (Amhara) the Belg season is the main production season. In Awi the off season is also important, whereas in West Shewa also the Meher season is of importance. In North Shewa (Amhara) almost all potatoes are grown in the Meher season (Gildemacher et al., 2009b). Tigray has a two peak in production: first half of the year based on irrigation and the second on rain fed (p 19) (Emana and Nigussie, 2011).

Figure 2 shows the long term precipitation deficit and weather data of Addis Ababa and table 3. contains these data and the solar radiation. The day night amplitude is greatest in winter with low cloudiness (4 °C difference) and is lowest during the rainy season (10 °C only). Daily solar radiation is highest during spring (about 23 $MJ.m^2$/day) , is lower during winter (about 21 MJ) with the sun at a lower angle and is lowest during the rainy season due to cloudiness (about 15.5 MJ).

Table 3. **Meteo data used for crop modelling (for the winter crop at 1,650 m.a.s.l.) three $_{o}$C were added for Tmax and Tmin to compensate for the lower altitude than Addis.**

Addis	Tmax (°C)	Tmin (°C)	Solar radiation (MJ/m²/d)	Rainfall (mm/month)	ETP (mm/month)
Jan	23	7	21.20	20	78
Feb	24	8	22.60	30	79
Mar	25	10	22.70	80	84
Apr	24	11	23.60	95	83
May	23	11	23.10	55	80
June	23	11	20.40	100	70
July	20	10	18.60	245	60
Aug	20	10	18.40	265	50
Sept	21	10	20.70	120	150
Oct	22	8	22.80	45	30
Nov	23	7	22.60	10	15.0
Dec	23	7	21.50	12	14.0

2.2 Calculated attainable yields

The crop growth model uses temperature as development parameter (a higher temperature leads to earlier emergence and leaf area development) and solar radiation for growth (2.5 g/MJ intercepted radiation) with growth slowing down when daily Tmax exceeds 27 °C and reaches 0 at 33 °C. The results of the model runs are shown in Table 4, for the three identified seasons Belg (pre-rain), Meher (rainy season) and the dry winter season. The highest attainable yields of 74 t/ha were calculated for the pre-rain season, followed by 61 t/ha for the rainy season and 55 t/ha at the winter season. The latter has the greatest need of irrigation water (3 mm/t), whereas the rainy season crop has an excess of rain so then irrigation is not needed.

It should be noted that developed production systems actual yields usually are 50-70 % of attainable and actual irrigation need is about 2x the calculated amount. So for Ethiopia Belg yields of 37, Meher yields of 41 and Winter yields of 36 t per ha seem economically quite feasible These results suggest 35 t/ha usually can be attained two times per year on a farm (preferably not on the same field to avoid soil borne diseases and pests).

Table 4. **Results of model runs for the three distinctive seasons .**

Modelled	Belg 15/3-5/7	Meher 1/6-20/9	Winter 1/12-20/3
Growing period (days)	112	110	109
Days between planting and emergence	14	15	14
Days between emergence and 100% ground cover	37	41	36
Days between 100% ground cover and harvest	61	54	59
DM tuber yield (ton DM/ha)	16.4	13.5	12.3
Attainable fresh tuber yield (ton/ha)	**73.8**	**60.9**	**55.5**
Economically Achievable yields (t/ha)	**37**	**30**	**28**
Soil field capacity (mm water / m soil)	120	120	120
Irrigation point (mm water / m soil)	100	100	100
Precipitation between planting and harvest	337	676	112
ETP between planting and harvest	198	194	197
Accumulated precipitation deficit (mm)	13	5	94
Soil water reserve (mm)	8	8	8
Irrigation need	**5**	**-3**	**86**
Irrigation need per ton fresh potato (mm)	**0.14**	**0**	**3.0**

3 Yields and production constraints

3.1 Yields and inputs

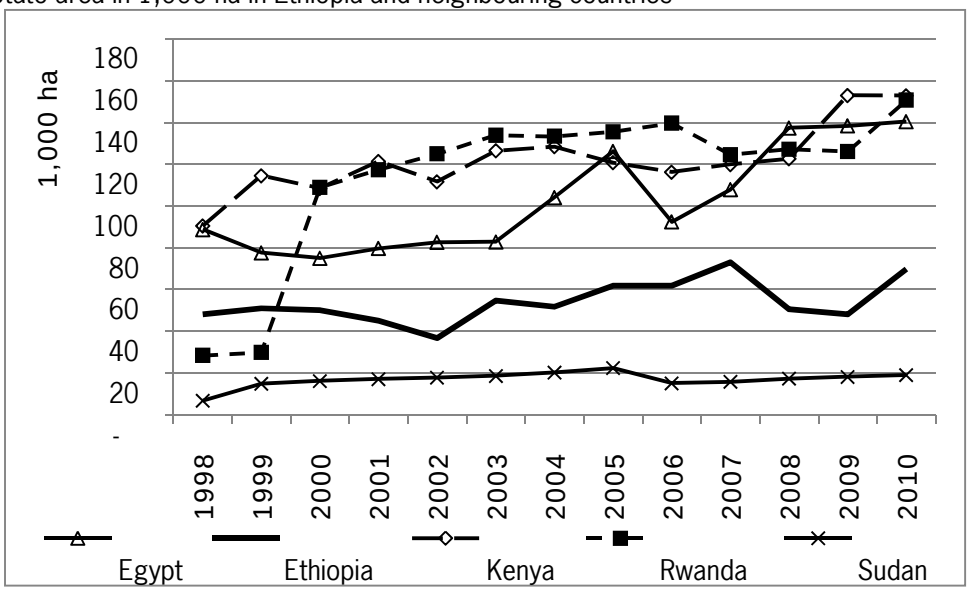
The actual potato yields per ha range between 8 and 12 ton per ha in Ethiopia, slightly below the average of Africa (Figure 3). In 2009 and 2010, Ethiopia achieved yields between 11 and 12 tons per ha, the highest level in the last decade. Nevertheless the yields are below those of Sudan (17 ton/ha) and especially Egypt (26 ton/ha). As is shown in table 5 the Ethiopian Central Statistical Agency mentions production levels of around 8 ton/ha.

In Ethiopia higher yields up to 50 per ha are achievable. The study of (Emana and Nigussie, 2011) shows even a maximum level of 64 ton/ha in Shashemene, however the minimum level has been 1.6 ton/ha. The mean is Shashemene with 14.3 ton/ha which is high compared to the CSA and FAO statistics. Furthermore, several experiments in Ethiopia show the potential yield levels at different levels of applied fertilizers. The trials show that yields above 30 ton per ha in different region and altitudes are within reach, if fertilizers are applied adequately. The results of (Ademu, Molla and Asnakech, Tekalign, 2010) show that only growing potatoes has the highest income, next potatoes with 75 % sorghum intercropping followed by 50 % and the lowest net income with 25 % sorghum intercropping. In all case growing potatoes increase the net income compared to growing solely sorghum. The study of Emana and Nigussie (2011) showed that intercropping with potatoes is not a common practice in SNNPR (below 10 %) and in Tigray (below 5 %). (Baye#Berihun and Mehatemwork and Mamo, 2010) show that the difference between total and marketable tuber yield ranges between 0 and 12 %. On average over all trials 96 % of the total tuber yields are marketable. In other words the losses on the field are 4 %.

Agro chemicals for sale in an agro shop (Gonder region).

Figure 3. **Potato yields in Ethiopia and neighbouring countries Source FAOstat).**

Potato area in 1,000 ha in Ethiopia and neighbouring countries



The trials are far beyond the actual practice in Ethiopia. Table 5 shows that the average amount of fertilizer applied on potatoes in 2010/2011 is around 20 kg N and 12 kg P per ha. In this average all farms are included from micro scale subsistence farmers to large scale growers. The average fertilizer use of the 336 households in the survey in Oromia and Amhara regions of Gildemacher et al. (2009) shows higher rates: 31 kg N/ha and 33 kg P/ha. The percentage farmers, using fertilizer in that survey, is with 57 % slightly higher than the 52 % in the CSA statistics. This gap between actual practice and the trial yields indicates significant opportunities for achieving higher yields.

Late blight fungicides available at an agro shop (North of Ambo region).

Table 5. **Potato yields in fertilizers trials.**

Source	Region	Trials	Yield	Evaluation
(Baye#Berihun and Mehatemwork#Mamo, 2010)	3 woredas (highland) in Gojjam, Amhara	5 levels of fertilizer: N/ P2O5 from 0/0 to 146/138 kg/ha Varieties: Gera, Serina and Birhan	Total tuber yield 6 to 34 t/ha, Marketable tuber yield 5.6 to 32.5 t/ha	Fertilizer application doubles gross farm margin
(Ademu#Molla and Asnakech#Tekalign, 2010)	Shewarobit, (1280m, Low land) Amhara	Potato intercropped with sorghum (0, 25,50, 75 %),	Marketable tuber yield 12.8 t/ha (75 % sorghum	Potato in cropping plan increases income. Sole potato
		fertilizer 165/195 kg/ha urea/DAP or N/ P2O5 110/90 Variety: ?	intercropping) to 21 t/ha (0% sorghum intercropping)	highest income, second, 75 % sorghum intercropping.
(Abay#Ayalew and Tesfaye#Dejene, 2011)	Angacha (2380m) and Kokate (2160m), SNNPR	4 levels of fertilizers: N/P from 0/0 to 73.4/26 kg/ha and 4 levels of compost from 2.5 to 10 t/ha. Reference trial: 111/39 or 73.4/26 + 10 t compost Variety: Tolcha	Potato tuber yield ranges from 13 to 36t/ha. Highest yield in the reference trial. Remarkable N/P doses is comparable to 73.4/26 + 10t compost.	Fertilizer increased yield, compost too but not significant. Higher N/P levels increase gross farm income with 15 to 50% and higher nutrient levels in soil.
(Zelalem et al., 2009)	Debre Berhan (2780m highland), Amhara	4 levels of fertilizer: N from 0 to 207 and P from 0 to 60. 4 by 4 factorial experiment. Variety: Gorebiella	Total tuber yield 22.5 to 49.4 t/ha, Marketable tuber yield 16.1 to 44.3 t/ha	Higher fertilizers delayed flowering and maturity. Dry matter content (%) decreases with higher yields

Crop cultivation in Ethiopia is based on low inputs. Even though that potatoes need significant levels of fertilizers, on 22 % of the crop area fertilizer is not applied at all. Only on half of the area inorganic fertilizer is applied (Table 6). The majority of the growers us indigenous seeds, only 0.5 improved seeds Improved seed is used in total on 248 ha by 11,584 holders: on average 215 m^2/holder.

Table 6. **Use of input for potatoes growing in Ethiopia in the Meher season.**

	Holders (%)	Area (%)	Kg/ha	Kg N/ ha	Kg P/ Ha
All fertilizers		78	1,020		
Natural	47	27			
DAP*	23	35	132	24	27
Urea*	2	2	158	73	0
Urea + DAP**	9	14	216	69	22
Total N or P/ha, weighted with area				20	12
Indigenous seed	99	100			
Improved seed	1	0.5			
Pesticide	9	25			
Irrigation	5	5			
Total potato growers (Total 100%)	1,133,017	54,007			

Source: (CSA, 2011b), Own calculation of Kg N/ha and Kg P/ha

* Urea 46 % N, DAP 18 % N en 46 % P2O5 (=20 %P). 1 kg P= 2.29 kg P2O5

** We assume that 50 % UREA and 50% DAP is applied

Yields are 10 t/ha whereas 30 t/ha should be quite attainable. The reasons for low actual yields are the following (not necessarily in order of importance):

- Soils that lack soil fertility e.g. lack of organic matter and or too high pH therefore binding phosphorus and not mineralizing nitrate.
- Remediation through organic matter amendment and fertilizer placement.
- Lack of good quality seed devoid of viral and bacterial diseases and at proper sprouting stage at the moment of planting.
- Non emergence likely due to brown rot (*Ralstonia solani*). Remediation through improved (basic) seed production and distribution.
- Unbalanced mineral nutrition. Farmers are familiar with nitrogen (DAP and Urea) and phosphate (DAP) but do not apply potassium. Demonstrations must encourage farmers for work on more balanced mineral nutrition.
- Unavailability and or insufficient and or inadequate application of fertilisers. Di-ammonium phosphate (DAP) (14 % N, 44 % P2O5) and some Urea (46 % N) is applied at relatively low rates of 100 – 180 kg/ha (about 22 kg N/ha). Potassium is not supplied at all to crops in Ethiopia whereas potato is a major user of this mineral. Remediation through fertiliser diversification and broadening and application according to soil fertility characteristics and crop needs.
- Late blight control takes place when the outbreak starts and usually not more than a few sprays per season with substantial losses occurring, especially during the rainy season around June. Remediation through introduction into trade channels of adequate quality controlled fungicides and decision support to growers when, how and how much to apply.
- Irregularity of water supply; to avoid too heavy rainfall and losses associated with late blight growers tend to extend the growing season to sometime before and after the most adequate water supply from precipitation thereby risking losses due to drought. Inadequate water supply from irrigation in dry season cropping also increasing the yield gap between actual and attainable yields. Remediation through
- irrigation schemes and schedules.

Late blight infection (Gonder region).

3.2 Suppliers of inputs

Government supplies input in packets in the framework of Ethiopia's Participatory Demonstration and Extension Training System (PADETS). Such packets contain high yielding seeds, fertilizers and extension services. In 2010/2011 3.6 million (28% of total) holders cultivating crops used the extension package on 2.2 million ha land (18 % of the land area) (CSA, 2011b). For potato growers these percentage are 12 and 15% respectively. The impact of these packages is significant. More than 50 % of respondents in the survey of Zerfu and Larson (2011) indicated that the production increased by 50 % and more than 50 % for another 20 % respondents. Only 7 % of the households felt that extension package were riskier than the

traditional practices. These results show as well as field and pilot studies that the economic returns to inorganic fertilizer application are larger than the costs. Nevertheless the use of fertilizer is low. Zerfu and Larson (2011) concluded that high transport costs (either fertilizer to the farmers or final products to consumer markets), limitations in complementary markets for credit and assurance, adverse climate and illiteracy limit the adoption of fertilizers. It is likely that these factors also incur low adoption of improved seeds as well as crop protection agents. The packets are sold on credit after a down payment of 10 to 35 % (p 14: (Zerfu and Larson, 2011). Fertilizer is bought for almost two third on credit and the remaining part on cash.

Agro shop selling agro chemicals and fertilizers (Region North of Ambo).

Table 7. **Fertiliser use in various systems.**

		Holders	Area (ha)	Share in area	Kg/ha
All crops	Total	13,228,068	11,822,786	100.0	
	Extension package	3,643,618	2,198,324	18.6	
	All Fertilizer		6,744,017	57.0	
	Natural	9,095,273	1,908,244	16.1	
	DAP	3,763,716	2,108,720	17.8	72
	Urea	885,447	301,487	2.6	79
	Urea + DAP	3,939,557	2,425,566	20.5	142
	Indigenous seed*	11,055,530	11,076,862	93.7	
	Improved seed	2,172,538	745,924	6.3	
	Pesticide	3,508,928	2,243,711	19.0	
	Irrigation	1,039,859	182,146	1.5	
Potatoes	Total	1,133,017	54,007	100.0	
	Extension package	130,587	8,194	15.2	
	All Fertilizer		42,151	78.0	
	Natural	529,281	14,620	27.1	
	DAP	265,228	18,746	34.7	132
	Urea	28,138	1,290	2.4	158
	Urea + DAP	102,708	7,495	13.9	216
	Indigenous seed	1,122,700	53,759	99.5	
	Improved seed	11,584	248	0.5	
	Pesticide	96,730	13,471	24.9	
	Irrigation	56,552	2,451	4.5	

(CSA, 2011e, CSA, 2011b)

* As in the statistics the number of holder and ha using indigenous seed is above the total, in this table the number of holders and hectare are the total minus the number and ha using improved seeds. Kg/ha concerns the fertilized area

The vision of production of potato in this document deals with high end consumer products and their supply chain and less so with the "remediation" aspects of the production constraints mentioned above. Current R&D and extension efforts are encouraged to continue along their current lines gradually increasing production

3.3 Enabling and supporting environment

Agricultural, Knowledge system

Higher yielding and resistant to biotic and biotic stress potato varieties are developed at nine research centres and at Haramaya university. Holeta research centre turns out to be leading: 14 of the 18 released improved varieties are developed at Holeta and Haramaya University the remaining 4. The other research centres are involved in wider adoption by farmers of the varieties released by Holeta (Emana and Nigussie, 2011). This approach of one research centre that develops varieties and others for distribution and adoption indicates some efficiency in using research funds.
Farmers develop knowledge by own experience or fellow farmers in their community on routine farming practice. Public and non-governmental extension actors are playing only a marginal role as a source of information according to Gildemacher et al. (2009b: p 192). However on some issues such as new seed varieties and crop protection agents, information from extension services, NGO's or research are of some importance. Farmers mention that these are for 23 % the most important source, for the issues seed selection, soil fertility, crop cultivation, post-harvest handling and marketing these institution are only mention in less than 10 % as most important source. Dissemination of farming practice and especially productivity

increasing methods is troublesome. The innovation system of research, public extension and NGO-intervention is characterized as central organized with limited mutual interaction. Furthermore in different potato growing areas universities are active, however not always in coordination with national research programs (Gildemacher et al., 2009b). Geunthner (p 3) "I *detected no problems with potato research and extension system. "*(Guenthner,2006) p4 "*The research and extension people also understand technology transfer"*

The government (EARO) has a national potato research coordinator: mr. Alemu Worku. In Appendix 2 a summary of his presentation is given. The coordinator is working as an agronomist at the Adet Agricultural research station (south of Bahir Dar). The position was shifted from Holeta to Adet as the region north of Addis Ababa has the largest potato acreage as compared to the region south from Addis. The number of researchers working in potato is 15; fields of work are: agronomy, breeding, economics, entomology, pathology. The annual R&D budget for experiments is Birr 196 000 (2012). Holeta is the largest unit, Adet has second position. The potato R&D program in Ethiopia is working with the International Potato Center: testing varieties for Ethiopian growing conditions. Three CIP clones were successfully introduced: Jalene, Gudene and, in 2009: Belette. These varieties have high late blight (LB) resistance levels in foliage. Signs are that the LB resistance of Jalene is decreasing.

4 Seed quality and varieties

4.1 Renewal of seed potatoes

The yield and quality of table potato production depend on the quality of the seed potatoes. The common practice is to use potatoes from previous harvest as seed potatoes. This practice incurs an accumulation of seed borne diseases or degeneration of the seed potatoes, resulting in lower yields and quality. Frequently, preferable each season, replacing the seed by high quality seed from specialized seed grower minimizes virus pressure and maximizes production potential. In Ethiopia only 1.3 % of the total seed requirement is met by relatively high quality seed (Gildemacher et al., 2009a).

- Seed potatoes are produced and distributed by farmers: 99 % is either taken from own stock or bought from other farmers (Gildemacher et al. 2009). This informal supply system has some disadvantages (Emana and Nigussie, 2011):
- Phytosanitary. In all Ethiopian potato growing areas late blight is common. The informal supply system poorly applies quality measures.
- Physiological. The common practice is to use potatoes that are too small or inferior for consumption.
- Physical. Tubers are damaged during all levels in the supply chain. For instance; holes are inflicted during harvesting with long sharp forks, or bruises incur during the packing in sacks and transporting.
- Genetic qualities. Mostly potatoes of unknown origin and varieties are used.

Diffused light store (DLS) at Solagrow's seed potato farm in Wenchly

The Ethiopian Agricultural Research Organisation (EARO) has started a seed potato production scheme.


The EARO mini-tuber production facility at Holeta

The scheme provides a limited number (500) of high quality seed potatoes to selected growers. These selected farmers receive the 'starters' seed free of cost and have an obligation to multiply and sell the seed potatoes after the first field cycle to local potato growers. This scheme operates in at least two regions: North of Ambo and south of Bahir Dar (around Adet). The seed growers multiply at higher elevations (> 3 000 m.a.s.l.) under very low aphid and virus pressure conditions. The participating growers, both the 'starters seed' receivers and the farmers receiving the field multiplied material are satisfied with this system. Field crops grown from second and more generation seed were vigorous, did not show virus symptoms and the yield may end up between 30–40 tons per hectare.


A freshly dug up potato plant

On the other hand farmers in the North of Gondar region had crops grown from seed purchased from neighbouring farmers. Their fields showed a mix of up to three varieties. The most late blight (LB) susceptible varieties were acting as LB inoculum source for neighbouring plants and crops. Moreover volunteer plants of susceptible varieties were acting as LB inoculum source. Apparently left over potato tubers remain in the field due to insufficient rotting and freezing temperatures in the soil.

4.2 Seed potato chain

According to the survey of Emana and Nigussie (2011) in Tigray and in SNNPR seed potato farmers sell 50 to 57 % of their seed to other farmers. Shashemene is seen as hub for the seed potato supply system. The formal seed potato supply chain is in the infant stage. Only one private company (SolaGrow, PLC) is active in Ethiopian seed potato production. The Ethiopian Seed Enterprise in not involved at all due to its limited capacity (Emana and Nigussie, 2011).

Diffused light store North of Ambo.

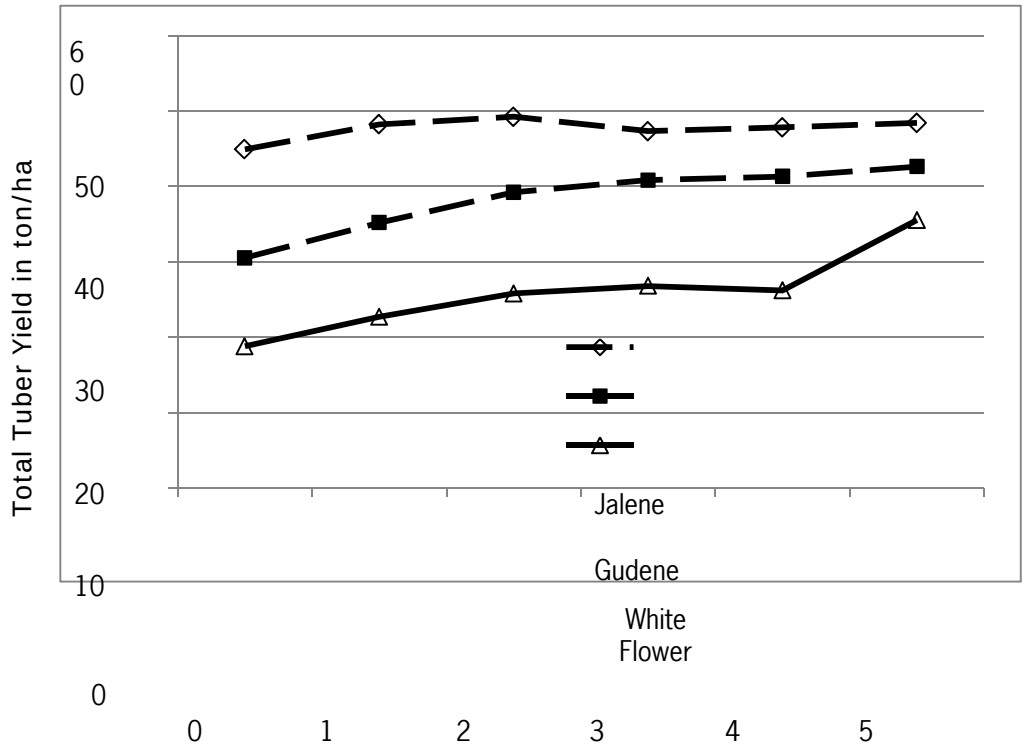
The study of Gildemacher et al. (2009) showed that 44 % of the Ethiopian farmers renewed the seed, thus meaning that 56 % never renewed the seed. The average renewal interval was three seasons in Ethiopia, for those who renewed the seed. The dominant source of new seeds was the village market (69 %). Neighbour (14 %) and specialized seed growers (16 %) provided the remaining part (Gildemacher et al., 2009b).

CIP bred variety Jalane (Jalene) was stored in a DLS store (Region north of Ambo).

4.3 Varieties

Currently 29 varieties have been released officially to the Ethiopian market. Most of these originate from the EIAR-CIP breeding program. (Mekonen et al., 2011) included three varieties with different levels of late blight resistance in their trials. The variety Jalene, high level of resistance, and Gudene, moderate resistance, were released by Holeta Agricultural Research Centre in 2002 viz 2006. Furthermore the local variety, White Flower, highly susceptible to late blight was included in the trials. The yields from the trial in Awassa are presented Figure 4. The fertilizers rate are 195 kg/ha DAP and 165 kg/ha Urea (111/39 kg N/P). First, the results show that yields of the local variety (White flower) with aforementioned fertilizer rates are twice as high as the actual average. Second, the improved varieties show higher yields without spraying: this indicates the economic opportunities of improved varieties. Without spraying the yield difference is up to 25 ton/ha and 5 times spraying the yield gap is still 13 ton/ha. Third, the high resistance variety Jalene shows a yield increase of a mere 3.5 ton/ha between 0 and 5 times spraying, whereas the difference of the local variety shows an increase of 16.5 ton. The improved variety has without spraying 10 ton/ha higher yield compared to the local variety with 5 times spraying. Almost comparable results were obtained from trials in Kokate.

Figure 4. **Total Tuber Yields of trials in Awassa with increased number of sprays against late blight.**



5 Diseases and pests

5.1 Late blight

Late blight caused by *Phytophthora infestans* is the most devastating disease in potatoes worldwide with an estimated annual damage of more than € 10 billion. Also in Ethiopia this disease is the number one priority of farmers in the management of their potato crop. Since potatoes and tomatoes are grown all year round, the late blight spores are always available and can infect potatoes when the weather conditions are favourable for infection. Late blight spores can infect when leaves are wet for several hours caused by rain, dew or mist. The continuous presence of spores implies that potato plants should be continuously protected against late blight during wet weather conditions. This can be achieved in two ways:

- Use of resistant cultivars or varieties made resistant (www.durph.nl)
- Protection of potato plants with fungicides

Late blight patch

Late blight affected plant (Gonder region)

Blight resistant varieties

In August 2012 the resistant varieties Jalena and Gudena hardly showed any late blight in the region of Shashemene and Ambo, whereas in the region west of Gondar these varieties were affected by late blight although in a lesser extent than the neighbouring local varieties. This last observation demonstrates that depending on the late blight population in the region the resistance of these varieties can be partially overcome by the late blight pathogen. This was confirmed by Alemu Worku. The recently introduced cultivar Belette (which we did not observe during our field visits) is supposed to have a good resistance level. Seed demand for this variety is high. Remarks were made that the culinary characteristics of Belette might not be as good as that of Jalene and Gudene. When the regional late blight population is not yet virulent for Jalena and Gudena, one spray with a fungicide will sufficiently protect the crop against late blight. When virulence is present (as we observed in the region west of Gondar), more sprays will be necessary to protect the crop. In the highlands in the region of Ambo we observed fields with Jalene and Gudene with serious early blight infections caused by *Alternaria solani*. Late blight was not observed. These crops had been sprayed with a reduced rate of fungicides resulting in “only” 500 gram mancozeb/ha. To effectively protect potatoes against early blight the minimum dose rate of mancozeb needs to be 1500 gram/ha. The farmers diagnosed the leaf spots as late blight and therefore used the more expensive metalaxyl-containing product in a reduced rate.

Late blight fungicides

Potato plants can be protected against late blight infections by spraying the plants with fungicides. The fungicides we observed in agro-shops are presented in table 1. Different product names and compositions were available which can be confusing for farmers. Also the prices varied widely. In one agro-shop we were shown an unlabelled bag with a white powder to control late blight. The shopkeeper did not even know what the composition and dose rate was! The products used most frequently to control late blight are the

"mancozeb" and "mancozeb+metalaxyl" containing products. Both products preventively protect the crop. "Mancozeb+metalaxyl" also has a curative and an eradicant (stop) efficacy. Farmers told us that they usually start spraying when they observe the first symptoms. When they spray "mancozeb+metalaxyl" this will stop the disease to some extent. When they spray the purely preventive product containing only "mancozeb", the efficacy will be much lower. Several remarks can be made regarding the use of fungicides. The best efficacy is obtained when products are sprayed preventively, in other words before the first symptoms can be observed. When spraying starts after appearance of the first symptoms, the efficacy is lower which can only be compensated by more frequent sprays and higher costs.
Spraying "mancozeb+metalaxyl" on a crop with late blight infections increases the risk that the late blight pathogen will develop resistance to "metalaxyl". In the Late Blight profile of Ethiopia it is stated that 20 % of the collected isolates were resistant. In many potato growing regions worldwide where metalaxyl has been used on existing late blight infections, the resistance to metalaxyl is widespread (e.g. Europe, Vietnam) and the use of metalaxyl should be restricted or not be recommended any longer. Several growers especially in the region west of Gondar complained that the metalaxyl-containing products were not effective in 2012.
Monitoring of Ethiopian late blight population to investigate the status concerning the metalaxyl resistance, mating type and virulence for R-genes. This information can be used to optimise spraying strategies and select the most appropriate R-genes for introduction in Ethiopia.
Investigating the possibility to introduce other late blight fungicides with a higher efficacy and better environmental and toxicological profiles than mancozeb. Products with good efficacy on downy mildew in roses are imported in Ethiopia. These products also have a good efficacy on late blight. A list of products to control late blight is available on www.euroblight.net.
The efficacy and economic benefit of optimal spray strategies can be demonstrated to farmers.
The timing of the fungicide sprays is crucial. Preventive is always more (cost)effective compared to curative/eradicant sprays. Investigate the possibility to provide growers with information on the optimal timing of their sprays. Using weather data, late blight models can provide such information for example on the mobile phones of farmers. In the region west of Gondar the late blight pressure was experienced as extremely heavy in 2012 resulting in serious crop losses caused by late blight. This can be caused by a more critical weather conditions or the occurrence of metalaxyl-resistance or the occurrence of a more aggressive late blight population. Using late blight models the critical weather conditions of 2012 can be compared with other years. Monitoring the late blight in this region will provide information on aggressiveness and metalaxyl-resistance.
Investigating the possibility to introduce R-genes in varieties using the cis-gene technique. In the DuRPh-project (www.durph.nl) this cisgene marker-free modification is used to introduce R-genes in potato varieties with for example good processing characteristics.
All sprays are applied with knapsack sprayers. The efficacy of the fungicides is highly dependent on the right application technique (spray droplet size and spray volume). The optimal spray technique can be demonstrated to farmers using water sensitive paper.
The film "Sustainable control of late blight in potatoes" produced by Wageningen University Research in which all important knowledge on the late blight pathogen and its control practices are explained can be translated in the Amharic language.

5.2 Bacterial Wilt

Bacterial wilt (*Ralstonia solanacearum*) can cause serious wilting in potato crops. Whereas late blight is always mentioned as the major constraint for potato production, bacterial wilt is a growing problem in some areas and is sometimes ranked as more serious than late blight. Sengooba & Hakiza mentioned that in Ethiopia crop losses caused by bacterial wilt can amount up to 45 %. We observed bacterial wilt in one discarded tuber in the Shashemene district: we did not observe symptoms in the field. In the region west of Gondar we observed in one field with a local variety a serious infestation with bacterial wilt as well as with late blight. We estimated that 50 % of the plants were infected with bacterial wilt. Bacterial wilt cannot be controlled with chemicals. The best solution for the problem is to use only healthy seed potatoes. The best approach to manage the bacterial wilt problem will therefore be to set up a seed supply system with high quality certified seed.

Bacterial wilt and late blight affected plants (Gonder region)

Table 8. **Fungicides sold in agro-shops in Shashemene, Ambo and Gondar with efficacy to late and early blight. The table presents the information mentioned on the packages of the products (product name, active ingredients, company, dose rate and package size). Also the prices are presented which varied from shop to shop. The efficacy for early and late blight is indicated with plusses. More plusses means a better efficacy. The efficacy ratings are published on www.euroblight.net .**

Fungicides Ethiopia									
Product Name	**active ingredients**	**Company**	**Dose rate kg/ha**	**ai/ha**	**Package size**	**Birr/kg**	**Birr/ha**	**Early Blight**	**Late Blight**
Ridomil Gold MZ Pepite	64% mancozeb	Syngenta	2.5	1600 g mancozeb	1 kg	400-600	1000-1500	++	+++
	4% metalaxyl-M			100 g metalxyl-M					
Ridom 80% WP	80% mancozeb	China	1.5	1200 g mancozeb	1 kg	150-250	225-373	++	++
Agro Laxyl MZ 63.5 WP	56% mancozeb	Singapore	3	1680 g mancozeb	500 g	250	750	++	+++
	7.5% metalaxyl			225 g metalaxyl					
Mancolaxyl 72 WP	64% mancozeb	India	3-4	1920-2560 g mancozeb	500 g	350	1050-1400	++	+++
	8% metalaxyl			240-320 g metalaxyl					
Unizeb 80%	80% mancozeb	India	1.5-2.0	1200-1600 g mancozeb	1 kg	190	285-380	++	++
Daconil 825 WG	82,5% chlorothalonil	Makthesim Agan	0.8-1.75	660-1443 g chlorothalonil	1 kg	287	230-502	++	+(+)
Tilt 250 EC	250 g/l propiconazole	Syngenta	0.5	125 g propiconazole	1 liter	700	350	+++	0
100 g metalaxyl-M = 200 g metalaxyl									

5.3 Virus diseases

In one field in the highlands north of Ambo virus symptoms in plants of Jalena and Gudena varieties were found. The symptoms were mosaic type, so most likely caused by Potato Virus Y (PVY). In all other fields no virus infected plants were observed. The problem with viruses seems to be limited.

5.4 Potato tuber moth

Potato tuber moth (*Phthorimaea operculella*) can cause losses in fields and during storage. We did not observe damage of potato tuber moth but the importance of the problem was confirmed by entomologist of Agricultural research Station at Adet. Control is carried out by treatment of diazinon and Neem in storage rooms. The insecticide diazinon was found to be available in the agro-shops.

6 Production costs

Four groups of potato growers and one individual grower were interviewed in August 2012 for the cost of production of potatoes per hectare. The table (Table 9) provides the summary of: cost, financial return and profit margin (Birr per hectare, € 1 = Birr 23 (December 2012).

Table 9. **Costs and revenues per hectare of four farmers' groups and one individual grower.**

Revenues-Costs	Group 1	Group 2	Group 3	Group 4	Grower
Total cost	20,750	24,298	33,352	17,418.5	37,975
Total estimated revenue	30,000	40,000	74,000	160,000	93,750
Revenue – cost	9,250	15,702	40,648	142,582	55,775

The maximum production cost per kilogram varies from Birr 1.90 (20 ton yield) to Birr 0.95 (40 ton yield).
The minimum production cost per kilogram varies from Birr 0.87 (20 ton yield) to Birr 0.44 (40 ton yield)
See Table 10

Table production costs at three presumed yield levels of the same interviewees as in Table 9.

Production costs (Birr/kg) at three yield levels (t/ha)	Group 1	Group 2	Group 3	Group 4	Grower
20	1.04	1.21	1.67	0.87	1.90
30	0.69	0.81	1.11	0.58	1.27
40	0.52	0.61	0.83	0.44	0.95

The low production costs provide great scope for processing and will have a rather sound competition with imported processed potato products. Processing needs more attention as it will lead to more financial turnover in the Ethiopian potato industry.
The constraints to production mentioned before are interdependent, meaning that the use of high quality seed is only profitable if planted in a fertile soil, adequately provided with fertilizers, water and crop protection.

The value addition in the supply chain to high end consumer products can best be exemplified by following the sequence of crops from minituber to table potato.
Vitro plantlet (variety A for table and variety B for processing into French fries)

Minituber	3 g	e.g. Wenchi
Seed tuber G1	300 g	e.g. Wenchi
Seed tuber G2	3000 g	e.g. Wenchi
Outgrowers G3	30 000 g	e.g. Meki
Producers for market G4	300 000 g	e.g. Meki

So every minituber produces 300 kg of marketable potatoes in the fourth generation (G4). Those may go to either:

- Sorting, grading and packing station, distribution to (super)markets
- Sorting, grading, washing, peeling, cutting, blanching, frying, cooling distribution to supermarkets, hotels and restaurants

Marketing in the rain in Gondar.

Most ware potatoes are sold at harvest. The large supply leads to low price levels: Birr 0.70–1 00 per kg. Potatoes for sale in wholesale and retail (street) markets in Gonder (August 2012) were healthy and showed good quality: very low internal and external damage. Some Rhizoctonia caused growth cracks were found. Typical tuber diseases as late blight, soft rot and brown rot were not found in the material for sale. Potato growers in the North of Ambo region complained about their problematic marketing specifically in relation to seed. They grow healthy seed crops and are fetching a good price (Birr 7-9 per kg) and wish to expand their business. But they lack sufficient marketing knowledge, tools and expertise.

Marketing along the road side is an art !

7 Marketing of potato and potato products in Addis Ababa

7.1 Benchmarking potato against other products

Awasha – capital of the SNNR – had a vegetable market (February 2012) with a few stalls among them one with (small) potatoes costing Birr 5 per kg. A supermarket with real carriages (no fresh vegetables) was found and here prices of staple foods was compared to those of potato. We can easily assume that the Birr 5/kg potato (20 % dry matter) has a Birr 25 equivalent of dry material rice, flour,..

Table 11. **Potato and other products found in a supermarket.**

- Potato Awasa vegetable market: Birr 5/kg
- Local Pringles 180 g Bir 44, 35 % fat and 50 g carbohydrates per 100 g
- Sunflower oil Birr 285/4 litre
- Soybean oil Birr 267/4 litre
- Maize oil Birr 456/5 litre
- Olive oil Birr 122/l
- Rice Birr 79/2 kg from Pakistan
- Flour Birr 130/10 kg
- Chick peas Birr 10/250 g
- Bread Birr 5/200 g (25 % H_2O?)
- Spaghetti Birr 22/500 g
- Mashed potato Birr 62/500 g (according to the shopkeeper, was sold out)
- Teff Birr 16/kg

Addis: potatoes in a supermarket (chique): Birr 9.50/kg washed and packed in closed plastic bag
Addis same supermarket: Chips Birr 5/bag (estimated at about 70 g)
Addis same supermarket Mashed potato Birr 56/450 g

A field with potatoes left for later harvesting (storage in the field) (Shashemene region)


Damaged tubers after about four months storage in the field (Shashemene region)

Potato competes well with other starchy products when displayed in bulk in the store for prices less than Birr 5 per kg. In high end supermarkets in the capital they compare well with other vegetables such as unions, turnips and tomatoes.

The consumption of chips (French fries) is increasing. Tesfaye et al. (2010) mention the following reasons:
1. Increasing urbanization. The urban population is 18% and it grows annually with 4%. This creates an increasing demand for food.
2. Upper income levels in urban region. High income households consume large quantities chips.
3. Increasing tourism. The international tourism receipts grew from 200 million USD in 2000 to up to 1,200 million USD in 2009. Tourists are important customers of restaurants.

Tesfaye et al. project a consumption of 45,000 ton/year of chips in 2015, which is around 90.000 ton of fresh potatoes. This amount is 20 % of the production. It looks like an optimistic outlook even if the present consumption is a mere 0.5 kg per capita (Tesfaye et al., 2010).


Washed potatoes for sale (Addis Ababa)


Potato chips (crisps) for sale (Addis Ababa)

One of the major constraints to increased production that has not been addresses is “Utilization”.
Page 26 (Emana and Nigussie, 2011). Chips are the most preferred potato product in hotels, bar and restaurants and the consumption is increasing (Tesfaye et al., 2010). Potato in the form of sauce is the most popular in Ethiopia households: a habit that is not used in countries like Burundi, Tanzania or Uganda. In these countries boiled potatoes and chips are the predominant consumed potato products. In Ethiopia boiled potatoes are second and crisps third. Chips prepared at home are mainly used by the high income households.

In October 2012 Xiaoyong Zhang carried out a survey in the capital on fresh and processed potato. The objectives were:
- To get a clear picture on the flow of potato chain in the Addis markets. E.g. how much potatoes are used for processing and how much is for fresh consumption at different market outlets (wholesale markets, small food stores, supermarkets, and hotel/restaurants etc.)

- What are the market outlets for processed potato products (French fries, chips, mashed potato, potato powders, etc.) and packaged fresh potatoes ?
- What are their market size now ?
- What is the expectation for the future ?

7.2 Market and consumer study 2012 Methodology:

Given the lack of secondary data available, first hand data collection has been applied. With the great help of FFARM, a group of eight university graduates were recruited for four days to carry out interviews and collect data on the fields. Each of the team members was assigned a specific task every day to interview one of the four categories: wholesale markets, small food stores, supermarkets, and hotel/restaurants. At the end of the day, the team member reported to Dr. Zhang about their market information. Suggestions and comments were shared and exchanged within the group. Table 12 lists the eight graduates and Table 13 shows their interview activities.

Table 12. **Name list of the eight graduates.**

No.	Name	Educational background
1	Besha Yigeiu	Sociology
2	Matiyas Yonas	Law
3	Tigist Achaiu	Midwifery
4	Yodit Testaye	Management
5	Sisay Yadete	Computer Science
6	Tigist Muiu	Agro-economics
7	Selamawit Teressa	Law
8	Teshome Gerdengne	Applied chemistry

Potato chips (Addis Ababa)

Table 13. **Interview activities.**

Groups	Wholesale markets	Small food stores	Supermarkets	Hotel/Restaurants
7+8 (Selamawit+Teshome)	day1 Piazza wholesale market		Get farm supermarket; The Twins supermarkets; Bambise supermarket	Day 2 New York restaurant; Damu hotel; Warsma Hotel; KZ-hotel; Intercontinental Hotel; Queen Sheba International; MN International Hotel
1+3 (Besha +Tigist)		Day 1 Four small food stores at Piasa, Arat Kilo and Gerji regions	Adadir supermarket; New York supermarket; Olive supermarekt; Ethio supermarket	Day 3The Lion's Den Hotel; Corta International Hotel; Hotel De Leopol International
2+4 (Matiyas +Yodit)	Day 3 Shola market; Piazza Atkilt Tera		Day 1 Shoa supermarket; Fantu supermarket; Friendship supermarkets;	
5+6 (Sisay +Tigist)	Day 2 Marcatto wholesale market	Day 3Two stores from Mexico subcity; one store from Meqanania subcity		Day 1 Ghion hotel; Global Hotel

7.3 Marketing study 2012 Results:

7.3.1 Wholesale markets

Piazza wholesale market: There are around 70 potato wholesalers in this largest wholesale market in Addis Ababa. Each sell between 40-70 quintal fresh potato per day (1 quintal is 100 kg). Their potatoes are mainly coming from Shashemene and Asella regions at the south of the capital. Their main customers are retailers and individual household consumers. Supermarkets are special segments who demand large size and good quality products. Wholesaler's purchase prices from farmers are around Birr 18,000 for 70 quintal (one truck), including Birr 4,200 of other costs for labour and middlemen. For top quality Grade 1 potatoes, the price is Birr 3 per kg while Birr 2.5 per kg is charged for grade 2 and Birr 2 for grade 3. In general, wholesalers feel an increase of potato transaction over the years although it is very much dependent on the production and harvest. The major challenge is the poor organisation along the potato supply chain. Farmers often sell their potatoes to the middleman without knowing the marketing prices. Middlemen often take the advantage of their closer contacts with farmers and push prices high to wholesalers. Unpredictable weather conditions are a great threat to the stable potato supply.

Marcatto Market: There are only 2 or 3 potato wholesalers in this markets. They co-exist with retailers in the same outlet. One interviewed wholesaler purchases their potatoes directly from farmers at Nazareth at a price of Birr 1.90 per kg. It is cheaper because potato quality from Nazareth is not as good as from Shashamane. The transport cost is Birr 4,200 for a FSR truck which can hold 55 quintal. It is equivalent of Birr 0,75 cent per kg. He could sell one quintal to local retailers at Birr 3,25 to 3,50 birr per kg. He also sold small proportion to consumers. One retailer who bought potatoes from this wholesaler sold the potatoes to individual consumers at Birr 4 to 4,5 per kg. Another retailer who bought Shashemene potatoes from Piazza sold their products to individual consumers at the prices of Birr 4.5 to 5 per kg. Wholesalers hold a medium optimistic attitude toward the future of their business. They believe that there is a general trend of increasing demand for potato products. But the unstable supply of potatoes and unpredictable weather conditions are the major threat to their business.

Shola market: is one of the big markets next to Piazza. In Shoal market there are a total of 15 wholesalers who sell both potatoes and vegetables. The volume they sell per year is on average 6,000 quintal potatoes per year, they sell from 15-20 quintals per day in rainy seasons and 9-10 quintals per day in sunny (dry) seasons.
They buy the potatoes directly from the farmers, the place where they buy the potatoes varies from season to season. From June – October they buy from the south part of Ethiopia which is Shashemene. Then from October – February which is the sunny (dry) season in Ethiopia they buy from Asella and northern part of Ethiopia which is mainly Menagesha and Gojam.

There customers vary from season to season. In sunny season super markets take 45 % , individual consumers take 35 % and hotels take 20 %. But in rainy seasons super market take 5 % personal consumers take 70 % and hotels take 25 %.
The wholesalers get potatoes from farmers by Birr 4 and Birr 0,50 at sunny seasons and from Birr 1,50-3,00 per kg in rainy seasons. The collecting price is Birr 30 per quintal. The grading cost is Birr 10 per quintal. The retailer prices is Birr 5,50 per kg.
This information is based on this season trade.

Farmer_____Birr 4.5 per kg
⇩
Agent _____increase Birr 0.20 per kg: Birr 4.70
⇩
Wholeseller_____Birr 5.00 per kg
⇩
Retailer _____Birr 5.50 per kg
⇩
Customer_____Birr 6 per kg

The transportation cost is Birr 41.60 per quintal and Birr 2,400 per truck which holds around 60 quintals.

PIAZZA ATKILT TERA: In this market there are a total of around 17 large wholesalers. Their trade volume is around 11,000 quintal per year, which is around 30 quintals per day. The product comes from the southern region and Oromia region, mainly Shashemene.
Their customers are hotels (10 %), retailers (50 %), consumers (5 %), supermarkets (35 %). The farm gate price is from Birr 2-2.50 per kg. The sorting/ grading cost is Birr 10 per quintal. The wholesale price is Birr 260-300 based on its quality. The retail price is from Birr 3.50 per kg which is Birr 350 per quintal, the retail price is Birr 4.00-4.50 per kg.

The information below is based on this season's trade.

Farmer_____Birr 2.50 per kg
⇩
Agent _____increase Birr 0.20 per kg: Birr 2.70
⇩
Wholeseller_____Birr 3.00 per kg
⇩
Retailer _____Birr 3.50 per kg
⇩
Customer_____Birr 5.50 per kg

7.3.2 Small food stores

Radiat Small Food Store: Radiat was founded in 2002 and started to process and sell French fries and chips in 2009. By that time they bought fresh potato at Birr 2.40 per kg which can make 4 packs of French fries (around 10 to 15 gram each pack). They sold the French fries at the price of Birr 2 per pack. Due to the rising of all costs (oil, potato and ketchup, etc.), they sell the French fries/chips at Birr 3 to 4 per pack

now. Every month they process about 1 to 2 quintal fresh potatoes which they normally purchase from "Atakilt Tera'. The processing is done manually. Thus only a small quantity can be produced. This activity is becoming very attractive over the last three years. The family gains substantial profit from it.

Several other food stores also expressed great expectation for the next five years. They are looking for small processing machines to increase their production. More of these consumers are students who go for cheaper and fashionable products.
Two stores from Mexico city and one store from Meqanania city were interviewed. The business of two stores from Mexico city are quite identical. They all get their fresh potato from wholesalers in Mercato with a price of Birr 4 to 4.5 per kg. They process up to 3 kg of fresh potato per day. From 1 kg of processed potato French fries they get Birr 15 to 20 revenue (they sell one small paper bag of French fries at Birr 2). They prepare and sell potato French fries after 3:00 pm because the number of customers are high after this time. They are optimistic about the business future while they complain about the potato quality (too small and the variety not dry enough for processing). The boy from Meqanania subcity also purchases potatoes from Piazza and sell his French fries at Birr 2. But he can manage to process 10 kg per day ! He is so busy all the time and can hardly find time to talk with us.

7.3.3 Supermarkets

Shoa supermarket: Washed and cleanly packed fresh potatoes are sold here at Birr 7.30 per kg. There is no potato French fries in this supermarket. According to the manager of this store, French fries are mainly produced in the local area and due to lack of supplier and lack of quality guarantee, they do not sell this product anymore. The potato chips branded Lays is priced at Birr 84 with 163 gram, imported from Germany. There is no potato powder available. But there is mashed potato imported from USA. The price is Birr 51.40 per 235 gram. The manager indicates that during the last five years, there is an increasing demand of potato products. The problem is all processed products have to be imported and the prices are going up fast. The local suppliers cannot guarantee their product quality and quantity. If there is a probability for establishing a processing factory in Ethiopia, there will be a high demand.

Fantu supermarkets: the washed and packed fresh potato were Birr 5.75 per kg. There is also deep frozen French fries imported from USA and priced at Birr 24.45 per kg. There are several packages of USA branded chips MAJIC TUNE. A pack of 180 g is Birr 48.50, 160 g is Birr 44.75, and 50 gr for Birr 17.75. There is no potato powder available. The manager also expresses an increasing demand on potato products over the years. The major challenge is the lack of domestic suppliers for high quality products and everything has to be imported with high prices. He would be happy to see if the imported products can be locally produced.

Friendship supermarket: this is one of the largest supermarkets in Addis but no potato and potato products can be found here. The manager understands the market quite well and he has good reasons for their decision. For fresh potatoes, they could not find reliable local suppliers. For processed potato products, they have to import. All these will end up with high price tags which consumers would not buy them.

Get Farm supermarket: This supermarket sells about 10 kg of loose potatoes at Birr 6.5 per kg. They do not wash potatoes in order to keep it healthy and longer. The local French fries are sold Birr 5.75 per 50 gram, Birr 6 per 100 gram, and Birr 10.45 per 200 gram. Foreign brands include Pringles (40 gram for Birr 29 and 182 gram for Birr 79) and also other brands from Dubai. Regarding the idea of sourcing commercially processed potato chips, they are willing to check on the basis of prices, quality and customer demands. No frozen French fries are found.

The Twins supermarket: They do not have fresh potatoes in the market. The local French fries are sold at Birr 7 per 100 gram. Imported cracks (potato mixed with other ingredients such as sour cream and onion) can be found at 50 gram for Birr 22 and 180 gram for Birr 43.35. The local French fries sold better because it is cheaper. Imported ones are mainly for foreigners. The manager has no confidence-t in potato French fries in the future since he expects more people will join this business to push the prices down (thus lower profit for him). If the local products cannot be sold or have quality problem, he can bring it back to the

supplier and exchange for new packs. But if the date of imported French fries is expired, they have to discard the French fries which makes a loss for the supermarkets. They welcome locally produced high quality potato products.

Bambise supermarket: This is one of the largest and well-known supermarkets where many foreigners are shopping. The fresh unpacked potatoes are sold at Birr 5 per kg. Local French fries are sold at the range of Birr 5 to 9 depending on the net weight. Imported French fries are Hungry Jack, 403 gram for birr 181 and P mister potato barbecue, 160 gram for Birr 46.10 imported from Malaysia. Also mashed potatoes are imported from Dubai with 200 gram for Birr 50-60. Two types of deep frozen potato French fries were found. One is imported from Dubai and the other is produced locally, called Sweet Golden Colour. Their website is www.ethioAmstel.com. But their website is not active.

Next four more supermarkets were visited: Adadir supermarket around Arat Kilo; New York supermarket in Bole, Olive Supermarket in Gerji and Ethio supermarket. In general, the potato and potato products are attractive over the last few years. The supermarkets profit from it. They get their fresh potatoes from 'Atakil Tera' at the prices of Birr 4.5 to 5 per kg. After washing and packing, they sell at Birr 7.35 per kg at their supermarkets. Their daily sell is about 25 to 50 kg per day in each supermarket. Two colours of local chips (white and brown) are found in the supermarkets with prices of Birr 5 to 6 per 100 gram. The supermarkets sell 100 to 200 packed local chips in 10 to 12 days.
Most of chips are imported, however: Master Potato Chips: net weight 160 gram, price: Birr 46 in Arab language (unknown original country). Lays: net weight 159.9 gram, priced at Birr 84, imported from Mexico. Furthermore, mashed potatoes are also found at Shoa Shopping Center. Net weight:235 gram, priced at Birr 67.29, imported from USA. The major problems the supermarket mentioned are: absence of the local factory that can produce this products in large quantity and high quality and lack of enough space for supermarkets to make potato French fries and chips themselves.

7.3.4 Hotels and Restaurants

Global Hotel (4 star): This hotel makes an agreement with a fresh potato supplier who should supply the hotel 3 days in a week at the price of Birr 8 per kg. If the supplier violates the agreement and the hotel has to buy higher priced potatoes from the supermarkets, the losses will be covered by the supplier. The hotel sell potato French fries at their menu for Birr 37.90. No potato chips and mashed potatoes are made. The manager believes that the market demand for potato French fries are increasing in the future. They will continue to make French fries themselves even if it is commercially available.

Ghion Hotel (4 star): This hotel purchases fresh potatoes from wholesalers by contracting at prices of Birr 6.50 and they need 70-80 kg of fresh potato per day. Both potato French fries (mainly) and mashed potatoes are prepared at the hotel. The French fries at the menu is Birr 20 and Birr 22 for mashed potatoes. He also believes that there is an increasing demand on potato products. The major challenge is the quality of potato for chip processing.

New York Restaurant: they make French fries and sell at Birr 21.30. People can also take it away for consumption with a paper bag. They also use French fries to make other menus at higher prices. The same owner also has a New York Supermarkets. They buy potatoes from the wholesalers and have them stored in the supermarkets. The restaurant will take potatoes from the supermarket when it is needed. They mention the potato quality as a major challenge: disease, dirt, and damage. Furthermore potato price fluctuations and government interfere on prices are another concerns.

Damu International Hotel (3 star): Their French fries are sold at Birr 29 per portion. When mixed with chicken and others, the menu will be at the range of Birr 50 to 70. They also make mashed potato themselves. The marketing is expanding given the increasing demand. Potato quality and price fluctuation are mentioned as the concerns.

Warsma International Hotel (3 star): The potato suppliers send washed and packed potatoes to the hotel. The hotel makes French fries, chips and mashed potatoes. The French fries are sold at Birr 30 per consumption.

KZ-hotel (3*): They receive potatoes from wholesalers. The French fries from this hotel are priced at Birr 30. They also make mashed potatoes as ingredients for other dishes. Potato quality and price fluctuation are reported as challenges.

Intercontinental Hotel (5*): This hotel buys potatoes from wholesalers twice a week at the range of 10 to 20 kg each time. The prices is about Birr 3-5 per kg. They have machines to make French fries and sell at the prices of Birr 31.65 per dish. About 3 to 4 potatoes are needed to make a dish. There is certainly an increasing demand of potato products. But Food and Beverage manager has no intention to buy processed potato products externally. They prefer to do it themselves because they can get the fresh products as they need.

Queen Sheba International (4*): This hotel used to buy potatoes from supermarket. But they were not satisfied with the quality from the supermarkets. They now switch to source from wholesalers at the prices of Birr 4 per kg. The freshly prepared French fries is sold at Birr 28.60 per dish. The manager prefers to prepare fresh potato French fries and has no intention to switch to packed products from outside.

MN International (4*): This hotel makes both French fries and mashed potatoes. The prices for French fries is Birr 26.50 per dish. There is no doubt that consumption of potato products is increasing. The food manager also expressed that they have no intention to switch to French fries produced externally because their customers prefer freshly made products.

Axum hotel (3*): This hotel buy fresh potatoes from local wholesalers at the prices of Birr 3-5 per kg. But they complain about the potato quality problem. They price the chip dishes at Birr 24.

The Lion's Den Hotel (3*) and Corta International Hotel (4*): They source potatoes from the supermarkets, wholesalers and a commercial potato farm call Genesis in Debre Zeit/Bishoftu. The potatoes from the supermarket is about Birr 5 to 6.5 while from Genesis farm, it is about Birr 4 to 5, excluding transportation costs. They need 2 quintals of fresh potato in a week to meet all demands. Their French fries and chips are priced at Birr 12 to 14 per 150 gram. They also have a potato porridge dish priced at 34 birr. These hotel managers are eager to see locally produced potato French fries and chips and they are willing to purchase them at reasonable prices. The major problem is the lack of frozen products available in the markets. Furthermore the potato quality is damaged during the harvest (cutting and wounding)

Hotel De Leopol International (5*): They have contracted suppliers form Atakil Tera wholesale market. Every month they sign a contract for an agreed prices. They need 250 to 350 kg of fresh potatoes per week. From these potatoes, they make various dishes such as French fries, chips, roast potatoes, potato soup, etc. Roasted potato is priced at Birr v25 to 30 per 200 gram; a cup of potato soup is Birr 14 to 17; French fries is Birr 6 per 150 gram; The good manager expresses that they do not want to switch to source potato products externally since they want to create employment opportunities for their workers. The major problem they face is the fluctuation of potato prices. There is no doubt that the demand of potato products will double in the next five years.

8 Manufacturing of chips (Frozen) French Fries

8.1 Production procedures

On March 13, 2011 Romke Wustman and Anton Haverkort met with Dr Martin Keijbets at PRI in Wageningen. Martin used to be director R&D at AVIKO and is quite knowledgeable on potato processing. When setting up a line at or near Addis Ababa the following needs to be addressed:

There is a difference between "Fresh Fries" (chilled) and "Frozen Fries (frozen to -20 Celsius). Fresh fries are fried a few minutes longer and contain less water (65 %) and more oil (5.5 %) than Frozen (72 % water and 4.5 % oil). Note when calculating amount of oil needed: always add 0.5 % because of losses.

Recovery roughly is 50 % (1 t of potatoes yields 0.5 t of French fries). A higher recovery is attained when dry matter concentration of raw material is higher, length/width ratio is greater, steam rather than carborundum peeling is applied and tubers have less defects and less reducing sugars (leading to less brown fries).
Assume that tubers arrive at the factory washed and graded (40-75 mm) and then are peeled in a carborundum drum. Subsequently cut in strips with a (Usher (USA), FAM (Belgium) or Fines (NL)) cutter.
Optional: the strips are blanched for a few minutes to arrive at a more homogeneously coloured and pre-cooked product. After blanching strips need to be dried (shaken).

Next step is frying at 160 °Celsius (1 minute) or 140 °Celsius (1.5 minute) in oil without trans-fat (Trans fat is the common name for unsaturated fat with trans-isomer (E-isomer) fatty acid(s). Because the term refers to the configuration of a double carbon-carbon bond, trans fats are sometimes mono-unsaturated or poly-unsaturated, but never saturated. Trans fats are rare in living nature, but can occur in food production processes. So hardened fat is not suitable nor lin-seed oil nor Soy oil unless less than 1 % linolenic acid. Suitable are oil of palm (refined), canola and sunflower. A shaker is needed to remove excess oil.
An apparatus to measure the water content of the cooled down product is needed. (infrared equipment exists).
Optional: next: use ambient (night) air to cool, assisted by refrigeration but oil will harden and sticks may stick together so moving from one conveyer to the next may be needed to avoid this. Have the factory located at a high cool site may be advantageous.
Packaging in boxes (fusts), plastic bags or plastic bags in a carton box on pallets. A weighing equipment is needed and a (potentially vacuum) sealer. At this stage hygiene in the factory is of utmost importance (gloves, hair netting) to avoid contamination with e.g. Pseudomonas.
Distribution (by order only) in a van with airco. Chilled fries for supermarkets with a shelf life of about a week need to be stored at 2-4 °Celsius in a Controlled Atmosphere bag (70 % CO_2 and 30 % N_2). Potatoes stored for a few days need to be chilled and the receiving end needs a fridge as well. Note: those fried at the consumer end within 12-24 hours after leaving the factory may need no refrigeration at all along the chain.

A cheaper alternative may be: just peel, cut in strips, add ascorbic acid, vacuum seal, and distribute (end users apply another deep frying before consumption.

8.2 Cost of chips production and investments

Tesfaye et al. (2010) calculated the economic profitability of 100 kg of potatoes into chips as shown in Table 14. The work clearly shows that the costs of Birr 214 per 100 kg of potatoes are well below (Birr 586) those of the gross benefits (Birr 828). Based on such figures a business plan for investments could be made. Investments such as in a plant consisting of the construction of the building and the purchase of machinery.

Table 14. **Economic profitability of processing 100 kg of potatoes into chips in Ethiopia.(Tesfaye et al. 2010).**

Particulars Unit Value per 100 kg of potatoes		
Costs		
Purchase of potatoes		Birr 127.55
Transportation of potatoes	Birr 8.31	
Labor for processing chips	Birr 30.00	
Additives (such as cooking oil)	Birr 51.52	
Depreciation value of processing utensils	Birr 2.50	
Frying fuel	Birr 22.5	
Total cost		***Birr 242.38***
Benefits		
Sale of one kg of Chips on average	Birr 18	
Quantity of fresh chips that could be produced from 100 kg of potatoes Kg 56.00		
Quantity of fried chips obtained from 100 kg of potatoes kg 46.00		
Gross benefits		Birr 828.00
Net benefit in local currency	***Birr 585.62***	
Net benefit in hard currency	***USD 68.90***	
(One USD = 8.5 Birr (2004))		

8.3 Elements of a business model

The establishment of a chips production line furthermore consists of three elements: 1) a business model, 2) an outgrowers' scheme and 3) research and development questions

The French Fries business model consists of the following elements
- Recovery 50%:1 kg Potatoes → 0.5 kg French Fries
- 100 ha x 15 T/ha = 1.500 T Processing Potatoes
- → 750,000 kg French Fries for Ethiopian Market per year
- Vegetable oil content 5-7 %; (50,000 kg)
- Estimated investment processing line: 1 M €
- 100 ha of production requires 300,000 kg of seed potatoes per year
- Complex organization of seed distribution, raw material collection, including contract growing
- Farmer knowledge and skills need attention
- Business group explores investment with PSI support

Potato production outgrowers scheme for French Fries production
- French Fries production requires suitable varieties
- Providing new opportunity for farmers
- Outgrowers scheme for seed potatoes
- Outgrowers scheme for French Fries potatoes
- Distribution of high quality seed potatoes
- Collection system for potatoes for processing
- Planning, farmer advice and production supervision
- Potatoes as a rotation crop with vegetables and field crops

Research questions related Public Private Partnership
- Late blight control scenarios for rainy seasons to allow for year round raw material supply
- Organizing sourcing from small holders
- Storage for up to two months; buffer for rainy seasons

- Product (cuts) – market – combinations; prices and outlets
- Quality raw material related to recovery (shape, dry mater content, colour, taste)
- Weather risks to the supply, agro-zones and those associated with climate change

9 Final conclusions

9.1 General

The vision “On the road to value addition” expressed in this paper assumes that current potato developments continue based on ‘business as usual’. Statistics show that yields are gradually increasing due to the diffusion of improved varieties, knowledge and availability of inputs such as seed potatoes, fertilizers and fungicides.

The research carried out in this project and as shown in this report shows the timely opportunity and prospects for a new paradigm alongside this continuation: the establishment of a supply chain for high end well-paying consumers with much greater added value for each link of the chain below them (packers, processors, graders, growers, (basic) seed growers and breeders. It is expected that once proven successful and sustainable in a commercial first factory more initiatives (me too’s) will become into existence.

In summary the highlights are that there are very good prospects for value addition with increasing numbers of urban consumers willing to diversify their potato consumption pattern including branded and packed fresh potatoes in (super)markets, chips and crisps. The environment in Ethiopia is very suitable allowing year round production and growers can meet the specifications if well instructed, guided and organized.

The Topsector project was funded by the Netherlands Ministry of Economic Affairs and an investor was identified wanting to operate a frozen French fries (chips) factory as of 2014. Regarding crucial aspects of the supply of potatoes to the high end markets the Conference in three themes each - 1. potato seed, 2. potato production and 3. processing - mentioned 5 challenges and their avenues for improvement to be followed up (next section).

9.2 Conclusion of three break-out sessions: Seed chain, potato production and processing

All participants of the conference were split into three groups for a break out session. Each group of about 15 persons of the break-out session discussed for one hour and was given the task to “detect” three challenges in their subject and solutions to them. The groups successively discussed.

9.2.1 Seed chain

This group discussed four major themes within the subject “Seed chain”, chaired by Shiferaw Wondimagegne (teamleader at FAO) and reported by Steffen Schulz (CIP representative)

- Ethiopian farmers make no distinction between ware potatoes and seed potatoes. They also fetch the same price. To remediate this, seed needs to be labelled by a seed certification system that as yet has to be set up for the emerging large scale potato production system. For small scale production informal inspection needs to be set up through which the seed quality improves gradually throughout time. EIAR could be instrumental here.
- There is a lack of awareness of what good quality seed may entail. Awareness creation can be done through demonstrations: seeing = believing.
- A key issue: the disease load of potatoes is only considered the 3rd priority(after variety and proper size and sprouting at proper time). This needs to be addressed by giving seed potato growers access to healthy nuclear stock and to give them the knowledge to maintain it healthy through various generations.
- Storage (varies from 3-8 months) and infrastructure are inadequate. Road infrastructure problem can partly be overcome by decentralization: this will strongly shorten the average distance the

seed needs to travel. There is a need for statistics regarding the real need of seed. If 1% of the total seed need of the country is covered what is the real need for the remainder, taking into account that the seed can be multiplied x (?) times before renewal pays off.

9.2.2 Potato production

This group discussed 5 themes within the subject "Potato production", chaired by Gebremeddin Woldegiorgios (EARO) and reported by Jeroen van Marrewijk (DLV Plant).

- Certified seed quantity is not sufficient: this was treated by the previous group
- The varieties that are available need to be described in terms of their suitability for table and processing properties, or dual purpose. There currently are 29 varieties of which most the best use is not known. To this end experiments need to be carried out. For export purposes late sprouting varieties are needed.
- Pest and disease control is far from optimal necessitating resistant varieties, clean seed and integrated control strategies.
- Total farm management (rotation, choice of crop, organic matter and soil fertility management,….) should be improved. What (not) to do. Train the trainer is one approach. Another to carry out (factor) analysis if one grower has 10 t/ha and his neighbour 20 t/ha find out how the latter did it and learn from each other.
- There is not sufficient continuity of knowledge streaming from the research centre to the grower. There is a need for a potato platform using Private – Public – Partnership as instruments. Follow the whole chain and find out which problems in which link needs to be addressed first.

9.2.3 Processing

This group first discussed what kind of processing and products currently exist, then their challenges and possible solutions, chaired and reported by Anton Haverkort (Wageningen University & Research):
Existing products:

- Graded, washed, sorted, packed, branded fresh potato for the supermarket
- Boiled of fried potato at home
- Chips at restaurants, frozen in supermarkets
- Crisps (locally made, imported from whole potatoes or reconstituted)

A common challenge for all products is to have the proper variety for each destination. Variety development in future needs to take this into consideration:

- For the fresh table potatoes in the supermarket the suitability of the potato for frying, baking o boiling for whole, mash or salad use should be indicated.
- For processing into chip and crisps the varieties need the following characteristics: shallow eyes, high dry matter concentration, proper shape (long for chips, round for crisps, low reducing sugars concentration.
- Development of skills: for all links in the supply chain: growing, grading, sorting, wholesaling, factory operations, supermarket operations.
- Pre- and post-harvest handling: curing of the potato to avoid skin chafing and bruising, instruct lorry drivers to drive slowly, packaging on lorries in accordance with risks of damage (boxes).
- Storage of potato over periods when there is lack of potatoes coming from the field (August September): growers think that the factory should store them, the factory thinks that the growers (association) should store them. The group could not make a decision.
- Collection and procurement. Several models exist and should be explored: direct contracting by the factory, use of agents or brokers, growers associations/cooperatives (possibly initially assisted by government (extension service ?) and or NGO's.

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Appendix 1. Program International Potato Conference

International Potato Conference Ethiopia - Addis Ababa - December 4, 2012

Chairman: Mr. Hans van de Heuvel, Agricultural Counsellor, Netherlands Embassy, Addis Ababa

08.00	hrs.	Registration
08.30	hrs.	Netherlands Ambassador: Opening
08.45	hrs.	Representative of the Ethiopian Minister of Agriculture: Statement
09.00	hrs.	Hans van de Heuvel: Netherlands agriculture: industry and government policy
09.30	hrs.	Alemu Worku: Overview potato research in Ethiopia; state of present research and objectives
10.00	hrs.	Steffen Schulz: Activities of the International Potato Centre (CIP) in Ethiopia and in the region
10.30	hrs.	Anton Haverkort: Yield gap analysis in Ethiopian potato production
11.00	hrs.	Break 30 minutes coffee tea
11.30	hrs.	Xiaoyong Zhang: Potato value chain: economics of potato production and marketing perspectives
12.00	hrs.	Marije Boomsma: Raw material sourcing from small holders
12.30	hrs.	Lunch
14.00	hrs.	Jan van de Haar: Solagrow's approach on seed potato improvement in Ethiopia
14.30	hrs.	Hans Wolf, Netherlands Agricultural Counsellor, Nairobi: Potato business developments in Kenya
15.00	hrs.	Teddy Muffels, Netherlands Agricultural Counsellor, Kigali: Potato business opportunities in Rwanda
15:30	hrs.	Break 30 minutes tea, coffee
16.00	hrs.	Romke Wustman: Business opportunity for potato processing in Ethiopia
16.30	hrs.	Workshops on:
	I	Potato production: chaired by: Gebremedhin (EIARO)
	II	Seed chain: chaired by: Shiferaw Wondimagegne (FAO)
	III	Processing: chaired by: Anton Haverkort (WUR)
17.30	hrs.	Plenary feedback session
18.00	hrs.	Closure

Appendices 2- 7 summarize the Conference proceedings
The summaries of the contributions to the conference on prospects (Haverkort), marketing study (Zhang) and business case (Wustman) are not given below as their content is incorporated in the bulk text of the previous chapters

Appendix 2. Overview of potato research in Ethiopia: State of present research and Objectives

Alemu Worku, Ethiopian Agricultural Research Institute, Adet, Ethiopia

Potato is an important food and cash crop in the highlands &in urban areas due mainly to the growing number of fast food industries and hotels. Potato is among the most efficient commodities for converting natural resources, labour and capital into a high quality food. Because of its short duration, it is very strategic for mitigating food crisis in disaster situations

The potato fits well intercropping and crop rotation systems, has higher yields per unit time & better nutritional values as compared to many food crops grown in the country. Research staff and facilities.

Facilities of the national potato research program include tissue culture and aeroponics laboratories screen houses and greenhouses for seed, laboratories for pathological and entomological research e-mail/internet connectivity and transportation for mobility of staff.

Major constraints to potato production and use are lack of improved potato varieties, diseases and insect pest, low quality seed and unavailability of an adequate seed scheme and poor agronomic practices used by farmers and poor post-harvest management.

The objectives of the potato research and development program are to improve the productivity of potato so that it can substantially contribute to the food security strategy of the country and used as raw material for the processing industries. More specifically:

- To develop high yielding, widely adaptable, pest and stress tolerant and used for processing
- To determine optimum agronomic technologies
- To develop storage structures and recipes

Achievements and impacts to date are:

- Variety development: over 29 potato varieties high yielding, disease resistant and early maturing have been released among other Jalene, Belete and Blete
- Agronomy: spacing, planting dates, fertilizer recommendations, riding frequency, seed size
- Crop protection: Integrated management of bacterial wilt, Chemical and varietal control of late blight, Integrated management of late blight
- Seed production: Tissue culture techniques for potato seed, Diffused light seed potato stores, Rapid multiplication techniques for potatoes, Positive and negative selections for clean seed production, Potato storage structures
- Potato recipes
- Mechanism of technology transfer: on-farm trials, farmer participatory research, farmer field schools,
- farmer field days and demonstrations, 0thers include field visits, training of extension agents and subject matter specialists, local and national radios, televisions and newspaper manuals, posters and leaflets

Opportunities and future research focus:

- Increase the yet 29 improved varieties developed
- Make more agronomic practices studied & standards available .
- Urban market prices continue to raise
- Development partners are available and are a good resource for use in dissemination of technologies
- There is a high demand among farmers for clean, high yielding potato seed

- Integration of stakeholders in planning and implementation of research and development and information flow
- Expansions of small scale irrigation schemes

Therefore the future focus will be on:

- Development and dissemination of high yielding potato adaptable to different agro-ecologies
- Development and dissemination of integrated nutrient management technologies
- Identification of mechanisms for efficient technology dissemination.
- Scaling up and scaling out adoption and impact of released technologies
- Product development to diversify utilization options and promote marketing opportunities.
- Developing post-harvest handling and storage technologies to reduce post-harvest losses and improve quality
- Capacity building for research, development, and monitoring and evaluation

Appendix 3. CIP in SSA and Ethiopia: An Overview

Steffen Schulz, International Potato Center (CIP), Addis Ababa, Ethiopia

Potato & Sweet potato have potential for as food security crops as they provide more food per unit area & per unit time than grain crops:

- Potato: 216 MJ/ha/day
- Sweet potato: 194 MJ/ha/day
- Comparison: 159 MJ/ha/day for maize and 135 MJ/ha/day for wheat

They are considered hunger Buster Crop as they mature before cereals & bridge hunger gap, are highly nutritious as they contain Quality protein and Vitamins and are less affected by food price inflation (they are not a globally traded commodities)

Research &Development priorities in SSA (Sub Saharan Africa) are being in where we are because of:

- Achieving food security
- Reducing poverty
- Improving health through nutrition
- Rural livelihood improvement

This through CIP's Main Thrusts in SSA such as:

- Genetic enhancement
- Seed Systems
- Climate Change Mitigation
- Agriculture and Human Health (OFSP, bio-fortification)
- Value Chain Development
- Crop Management and Crop Protection
- Training & Capacity building

Genetic Enhancement means to make genes and genetic products useful for priority constraints identified and utilized potato varieties with improved characteristics for late blight, viruses, bacterial wilt, drought and heat, .nutritional content (Vit. C, Zn, Fe) and yield

Small scale on-farm seed quality maintenance we work on through e.g. fleecing for virus protection in sweet potato nurseries, high density planting, for multiplication of potatoes in a healthy ("virgin") field, Positive and Negative selection, informal Seed Inspection resulting in Quality Declared Planting Material

In Ethiopia CIP works in collaboration with Ethiopian partners since more than 30 years. In 2009, opening of Country office in Addis Ababa and Regional offices in Hawassa & Mekelle, currently there are 16 staff, working on 7 on-going projects with a $2.5m annual turnover with major donors being USAID, Irish Aid, CFC, HarvestPlus, ADA. The R & D Priorities of CIP-Ethiopia & Partners are:

- Support national potato and sweet potato research programmes
- Introduce high yielding, disease resistant varieties and populations
- Develop decentralized seed systems to increase availability of quality planting material
- Establish informal seed inspection system (QDPM)
- Promote production & utilization of orange-fleshed and dual-purpose sweet potato
- Establish regional potato breeding hub for Sub-Saharan Africa

Appendix 4. Sourcing potatoes from Ethiopian smallholders

Marije Boomsma, Royal Tropical Institute (KIT), Amsterdam, The Netherlands

The Royal Tropical Institute (KIT) is a knowledge institute in international sustainable development. It was established in 1910 by Dutch companies and currently has 400 employees with a turnover of 45 million Euro and it is active in 65 countries. Beside R&D on development in a project department it has a Museum, Hotel, Library services and is a Publisher.

Challenges for a potato processing company in Ethiopia would be sourcing from smallholders (80% of all farms in Sub-Saharan Africa), the chain organization, quantity, quality /safety, consistency, transparency, side-selling (trust) and so. The Key Questions that emerge are: whom to buy from? and where? Models exist such as Contract farming models and Service models

As an example may serve: sourcing from Lead Farmers involving he following project steps

- Development, testing and introduction of new potato varieties and technologies
- Establishment of rapid-multiplication enterprises and collection centers
- Training of producer associations and credit groups (lead farmers and outgrowers)
- Development of contract/partnership mechanisms between producers, input providers, intermediate agents and agro-processors (later directly with SLBL)
- Training of input dealers and credit providers

Or the example sourcing from organized farmers by DEEPA industries owner of the brand Tropical Heat crisps (also sold in Rwanda)

- Raw materials specifications: Dutch Robijn potatoes, low sugar content, GAP (leaving potatoes for 7-10 days after natural death of the plant or haulm-cutting)
- Sourcing area: Bomet district
- Challenge: unreliable and irregular supply
- Solution: collaboration with producer organisations in Bomet to organise production

Or the case of DEEPA industries in Bomet (2)

- Vertical collaboration agreements: fixed price, organized transport, renewed production system
- First phase results (started 2005):
- The transporter replaced the load with low quality to deliver to the processor
- Producers refused to deliver at the fixed price during the low season when prices are high
- The processor was accused of disqualifying good quality when he could buy form elsewhere cheaper
- Lack of high quality seed potatoes hampered production
- Second phase (start 2010): more direct relations with farmers
- Development partners with knowledge of organising farmers, potato seed and supply systems provided assistance
- DEEPA invested in a local collection centre
- Outgrower farmers were trained on quality assessment at farm level
- A seed potato production system was set-up

Appendix 5 Potato sector in Rwanda.

Teddie Muffels, Agricultural Counsellor, Netherlands Embassy Kigali

Rwanda has a well-established potato sector, a large potato production, favourable growing conditions and a high consumer acceptance. Some potato facts are:

- Potato is the 3rd food crop, after cassava and banana
- Rwanda largest producer in East Africa, total of 150.000 ha, 1,8 million MT (2010)
- Smallholders with average of 0.5 ha
- Average annual production 12MT/ha, best 30MT/ha
- Popular food source, 80 (city)-250 (potato growing area) kg/person/year
- Expensive food crop, (seed, pesticide, land preparation), € 1,200/ha, approx € 100/MT
- Good returns almost € 2,400/ha
- Demand exceeds production
- Large government involvement

The strengths of Rwandan potato production are the suitable soil & climate for potato, the short production cycle (4 months) , high yields, the strong market demand, the cost competitiveness with neighbouring countries.
Its weaknesses are the high pressure of diseases, volatility and unpredictability of prices, the farmers' cooperatives not well organized, the limited availability of seeds, the virtual absence of storage or processing. Furthermore the use of fertilizers is low, the soil acidity increases, the long term land fertility increases and the relatively high costs of production. The use and costs of pesticides are high (6-8 applications of 3 different pesticides/crop € 120-220/ha) and the low availability and quality of seed.
The opportunities are the export markets, the potential for processed products such as chips, starch.
Its threats are the soil degradation and disease build-up and risk of crop loss due to unfavourable weather (excess rain).

The lack of adequate seeds stems from the hampered proper seed multiplication: farmers often grow >4 cycles from seed, purchase uncertified seeds, lack of access (no transportation) so there is a low incentives for seed growers because of the low profitability production of seed potato compared to ware potatoes (RWF 250-350 vs. 215) that is why seed growers often sell seed potato as ware potato.
Lack of adequate seeds also due to the fact that farmers often sell seed potato as ware potato, seed potato yields are lower and there is a 3 months gap between harvest and sale. There is an aeroponic/in-vitro culture for mini-tuber production (400.000 mini-tubers/season) in place but no scheme from pre-basic to certified seed: hence currently about 3% is certified.

The potato industry in Rwanda faces limited financing opportunities, is at risk of crop failure due to diseases, the quality of seed hampers continued high productivity and there is lack of processing, storage, trucks or equipment for land preparation limits finance assets and sales are hardly organized by growers. A key issue concerns post-harvest with very limited storage facilities- short production cycle and more potato crops/years requires storage max few months.
No processing capacity is available, there is limited washing and packing (added value doubles price) and there is some cottage industry producing crisps.

The Rwanda government policy focuses on the challenges of Seed Potato Production, Varieties (short term and long term), Plant health field control, Registration system (plant health and breeders rights), and Improving physiological age and on the Organisation & representation seed producers. The role of the Netherlands in Rwandan in relation with the organizing a potato study tour in November 1012, assisting MINAGRI in developing special Irish potato programme, linking Netherlands expertise (agribusiness and institutes) with potato development policies of Rwanda and joining forces with other major potato development partners (BTC, IFDC,)

Appendix 6. Seed potatoes: Kenya and the Netherlands united in increasing food security

Hans Wolff, Agricultural Counsellor, Netherlands Embassy Nairobi

Currently a Private Public Partnership (PPP) project is being carried out whereby seed potatoes from the Netherlands are imported to Kenya for further multiplication. This PPP seed potato project is due to the fast growth of Kenyan population (with 1 million per year, so for food security reasons), because of the very low production rate for seed potatoes (< 2% of the overall need for Kenya). More details are at www.potatoplatformkenya.com.

The expected effect on the current Kenyan situation is that currently Kenya is nr. 36 on FAO-list of African countries producing potatoes with a production level per ha below 5 ton. The aim of the project is to increase the availability of certified seed, to improving farm practices of small holders, to increase potato production with a factor 5 – 10 and to increase capacity of processing industry.

The following approach was chosen: in January 2012 a bilateral phytosanitairy agreement has been signed, in May 2012 the first container with Desiree seed potatoes was imported, seed potatoes were planted at certified farms with a harvest of 50 ton/ha which was all sold to farmers. The processing industry is highly interested in such material. Capacity building is part f the project with a visit to the Netherlands in July 2012.

There are some constraints to overcome: there is an underperforming government and there is no extension service, the knowledge levels of small scale farmers is very low and the landholdings are to small and get smaller all the time. So the question arises: should small holders be our target group ? Finally Kenyan stakeholders rather pursue personal interests than general interests.

Appendix 7. Solagrow's approach on seed potato improvement in Ethiopia

Jan J. van de Haar, Solagrow PLC, Hidi - Debre Zeit

The basic objectives of Solagrow are to provide improved inputs for Ethiopian farmers to increase their food crop production and profits, to create farmers market associations to get better market access and to export seeds to gain foreign currency. Solagrow PLC is a commercial seed potato production company and its pillars are:

- Commercial seed potato production
- Improved varieties
- Three varieties registered
- New varieties for processing and rain-fed crop such as Ceasar – Red Scarlett – Mondial
- Commercial seed potato production
- Improved varieties already three varieties registered
- New varieties for processing and rain-fed crop
- Basic seed production: mini-tuber production versus import -> Regional

The facilities of the company are: a screenhouse of 3,000 m^2 screenhouse at Haro Wenchi, a production plant of 5 million mini-tubers, i.e. annually 600 ha G3 = 15,000 tons.

These aims are met through the establishment of a molecular test laboratory and a seed potato production scheme consisting of

- *1st Propagation of basic seed January – May,* > 2,400 meter a.s.l.,Wenchi & Doba
  2nd propagation of elite seed , October – December, Between 1,600-2,000 m.a.s.l.
- *3rd: production of ware potatoes* Between 1,500-3,300 m.a.s.l., all over Ethiopia

The following elements are crucial to meet Solagrow's objectives: commercial seed potato production and improved varieties (already three varieties registered). Further need for new varieties for processing and rain-fed crop. A challenge will be to establish a basic seed production system in Ethiopia, so mini-tuber production in Ethiopia versus import seed potatoes.

Beside seed production, improved practices are crucial necessitating experiments and mechanization and testing of seed quality and certification. For commercial seed potato production
improved varieties are needed for which currently three varieties have been registered. New varieties need to meet the requirements for processing and rain-fed crop (meaning they have to be so resistant as to be successful in the rainy season.

Deliberations regarding (basic) seed production in Ethiopia

- Mini-tuber production in Ethiopia versus import from Europe -> Regional aspects
- Improved cropping practices are needed along with improved seed
- Investments in balance: experiments + mechanization + certification
- Balance in quantity of irrigated and rain-fed crops for year round production
- Supply and prices to be balanced: cropping plan
- Market access
- Strong links to be established to local and export to the region

Pillars of company strategy

- Whole crop chain: from breeding to eating, from forceps to fork
- 'Farm in chains' not only focusing on potato but whole farm
- 'Crop Rotation Approach' instead of 'Potato focus' : include 3-5 suitable rotation crops:
- Linseed, storage unions, brewers' barley, linseed (outgrowers with irrigation)

- Nucleus farms in midst of outgrowers: joint technology & marketing centre
- Regional approach meaning each potato growing area has its own seed and model farm
- All-round support to farmers, not just on potato
- Improved potato varieties: table & processing for a factory to be established
- Mini-tuber and basic seed production for quality seed production (> 75%) by commercial outgrowers
- Coaching of PG: training & demonstration
- Micro-credits for first investment
- Rental of machinery
- Market development up to consumers: export, processing and wholesale
- Nucleus farms in midst of outgrowers: joint technology & marketing centre
- Links to research & extension & education

In brief major attention to:

- Improved varieties
- Mini-tubers and basic seed
- Smallholders for final propagation
- Full crop rotation
- Rental mechanization
- Joint marketing & processing
- All supporting farming services