Sustainable potato production in Mexico

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Summary

The Memorandum of Understanding between the ministries of agriculture of Mexico and the Netherlands is aimed at strengthening cooperation in the field of research and development between the two countries. Within this framework CONPAPA, Sabritas, INIFAP and Wageningen University established contacts and set an agenda for sustainable potato production in Mexico that builds on experience in potato and other commodities in the Netherlands and other countries. During three meetings in Mexico in 2007 major sustainability issues were identified and means of addressing them were established as well as a working plan for 2008 and beyond. The three main issues to be addressed are 1) optimized use of the resources water and minerals, 2) improvement of the seed supply chain and 3) improved control of psyllids responsible for purple top. Pilots are planned to start in 2008 on these three themes. Moreover in 2008 a major national potato seminar is planned on sustainable production and organized within the framework of the United Nations International Year of the Potato (UN-IYP).

1. Introduction

1.1. Sustainable agricultural production

Since the 1960ies food retail and processing companies have successfully addressed food safety as a pre-competitive issue. Safe food is devoid of hazardous contaminants, toxins and pathogens. Tolerance levels are either zero or defined as maximum residue levels. HACCAP and ISO norms were established and compliance by food processing and trade is assured by accredited certification firms.

Although all agree that food should be safe, not all involved in food production agree on the definition of food safety nor on how to enhance sustainable production. Sustainability is defined in terms of the three P's of Planet (e.g. optimal use of resources such as water, minerals and energy and reduced emission of chemicals to the environment), Profit (e.g. reduced costs of production and increased yield, quality and market value) and of People (e.g. healthy production conditions, market access to benefit local communities).

Governments have made legislation that ensure food safety but regulations regarding sustainability are much less strict and at best forbid most hazardous biocides, over-fertilization, excessive use of water and destruction of natural habitats. A strong tendency is seen during the last decade through many

organizations of producers (e.g. EISA), processing companies (e.g. SAI platform) and individual companies (e.g. Tesco and Unilever) to define sustainability criteria and values. In contrast to food safety where strict quantitative values exist, sustainability is less easily defined by criteria and their values. Moreover the value of a sustainability criterion (e.g. the amount of crisps produced per liter irrigation water applied to the crop) strongly depends on crop and environment (location, weather) interaction.

Enhancing sustainability successively involves:

- defining the sustainability indicators per crop-environment combination
- quantifying both the acceptable value above which crop production is not harmful and the unacceptably low value below which no production is allowed to take place
- defining and implementing a strategy to move the value from below to above the acceptable value
- a monitoring system for monitoring progress

1.2. Mexican – Netherlands cooperation

Agriculture is a major economic activity in the Netherlands, greenhouse and potato production being one of the main sectors. Within the framework of continuously updating knowledge of North-South agricultural interactions, the Ministry of Agriculture, Food and Nature of the Netherlands annually makes funds available for small seed money projects. These funds are requested by the agricultural councilor of the Embassy of the Netherlands and activities (small projects that mainly enable travel, field and literature studies) are carried out by Wageningen University and Research Centre at Wageningen in the Netherlands. This way in 2006 Mexican-Netherlands cooperation started on innovation of sustainable greenhouse production (flowers and vegetables) which was continued in 2007 and was then extended with a potato project.

The objectives of the potato project are to identify areas in potato production in Mexico that will enhance sustainable production through the reduction and efficient use of resources (land, water, minerals, biocides, and seed). Furthermore, the identification of key stakeholders who jointly decide on solutions and to create consortia that will develop and carry out pilots and scenario studies. So, as far as Wageningen is concerned Mexico was identified because greenhouse systems and potato production are important in both countries and because of an alert agricultural councilor.

The main stakeholder in Mexico regarding the Mexican-Netherlands cooperation is CONPAPA, the organization of potato producers. Sabritas as host of some activities was most effective as the company is the largest processor in Mexico and has the advantages of Latin American leverage.

1*.3. Approach*

Anton Haverkort and Siert Wiersema of Wageningen University are conducting the activities at the Wageningen end. For 2007 the following approach is chosen:

- *Week May 1- 5, 2007 the Wageningen scientists meet with stakeholders in Mexico* (Toluca valley)
    - To discuss mutual wishes
    - To visit facilities and fields
    - To set priorities for 2007 in the meeting on Friday May 4
- *Fact finding mission in 1st week of August 2007(Anton Haverkort)*
    - To visit farmers and fields in Central and Northern Mexico
    - To discuss date, purpose, programme and venue of a National Potato Seminar in 2008
- *Planning of 2008 pilots November 13, 2007*
    - Obtaining common ground regarding sustainability issues in Mexico
    - Planning National Seminar 2008 (UN-IYP), see Annex 4.
    - Develop consortia working on subjects in 2008

The programs of all three visits of May, August and November are shown in Annex 1. Noted exclamations in Annex 2 and the people involved in the various sessions, meetings and visits are shown in Annex 3.

2. Observations

2.1. General

Potato production in Mexico takes place on about 70,000 ha and average yields are about 20 t/ha (17 t/ha on smaller farms in the central of Mexico and 23 t/ha in the North where large holdings dominate. In the North production takes place with irrigation in the rest production mainly depends on rainfall. The yields are higher than in many other parts of Latin America (with the exception of Argentina, Brazil and Chile) and also lower than in the USA and Canada. Reasons for the relatively low yields and high production costs are the following:

- Relatively short growing seasons with high risks:

- In the coastal plains production takes place in the cool winter period (November-march) with short days and relatively low solar input
- In the highlands the season is limited due to risk of frost with main season between April and September.
- Crops are often subjected to risk of hail, frosts, drought and flooding

- The use of seed of low quality:

- This does not hold for the processing industry (22 % of national production) since they have their own seed supply chains
- There is a seed scheme (G1-G6) for the fresh market but the bulk of seed is from informal sources. Farmers find certified seed unavailable and/or too expensive
- Seed production is costly as vector pressure is high and seed production does not take place in isolated designated areas
- Small holders plant 2.5 to 3.5 t/ha of seed potatoes, larger farms with higher yields up to 5 or 6 t/ha. Seed cost are high and multiplication rates are low (about 6 x whereas this is about 20 x in Northern America and Europe)

- Seed production is difficult in areas with year round production as cycles of vectors are not interrupted
- Lack of decision support based management leading to uncertain efficiency of inputs
- Chemical control of late blight, insects leaf hoppers, psillids, aphids and weeds does not take place based on monitoring and use of DSS but often follows routine leading to high costs and development of resistance against pests and diseases
- Irrigation usually does not take place based on DSS (meteo, crop and soil data) which may be responsible for sub-optimal use of water, yield and quality
- Fertilization of crops is not based on pre-planting soils analysis nor are supplemental nitrogen dressings based on DSS

2.2. Production systems

Mexico knows two main potato production systems:

System A.

Potatoes for industrial use (Sabritas and Barcel). Sabritas with the main share controls its complete chain from variety selection, seed cleaning, rapid multiplication, seed production and contracting of processing potatoes (about 250 000 t). Production costs are about 300 USD per ton which is about 3 x the cost of production in the USA, Canada, Argentina or northern Europe. The annual potato area of (groups of) growers in this category varies between 200 and 2000 ha. Sabritas' smallest contractant grows 200 ha and the largest 2,000 ha of processing potatoes. 98% of Sabritas' processing potatoes is grown in the North. Sabritas sources its 250,000 t of potato from 15 growers (or groups). They produce 5,500 t of seed for this amount of processing potato. Other processors (among others Barcel) process another 70,000 to 100,000 t per year. Between 3.4 and 3.9 kg of fresh potato is needed to produce 1 kg of crisps (oil excluded). This especially depends on the dry matter concentration that varies between 18 and 21 %. Sabritas stores about one third (80,000 t) of their needs for a few months 60 000 t in Los Mochis and 20 000 t in Chihuahua.

System B.

The table market represents about 800,000 t/year and is concentrated in the central part of Mexico. The fresh potato market with three levels of production (small holders (1 - 5 ha), intermediate (5-20 ha) and large farms (over 20 ha). The smaller the lower the yields are due to a more restricted use of inputs and worse quality of seed. The production costs increase from 200 to 300 USD per ton. This is about 2 x higher than the cost in the northern regions of North America or in Western Europe.

Regarding sustainability, the two systems (processing and fresh) face different aspects but have the following sustainability issues in common:

- better seed and varieties will improve the use of other resources, especially in rainfed fresh potato areas

- improved use of water and fertilizers will optimize their efficiency while increasing yield and quality, especially in the northern processing potato areas
- of all pests and diseases purple top caused by a phytoplasma and as vector paratrioza (psillids) most threatens potato production in both production systems.

The challenges to render potato production more profitable mentioned in the various meetings were based on an earlier national survey: the availability of good quality seed at affordable prices, the presence of bacterial diseases (noteably Ral*stonia solanacearum* and *Erwinia* spp.), the occurrence of purple top, soil fungi (especially *Fusarium* and *Verticillium*), late blight (control and losses), water (availability and management), tuber moth and mineral nutrition. Priority issues per State in descending order of urgency are shown in Annex 5.

2.3. Propagation material

2.3.1. Varieties

The kind of variety used depends on the type of supply chain:

- Sabritas' main varieties are Atlantic, FL 1876, Snowdon, Fiona and a little bit of Lady Rosetta. New varieties: through PICTIPAPA
- Barcel contracts Atlantic, Snowdon, Alpha, Gigant, Hertha, Fiona and Lady Rosetta. New varieties: contract with INIFAP
- Main table varieties are Alpha, Gigant, Mondial, Fiona, Vivaldi, Belzira and Escort. Source of new varieties: INIFAP.

Since there is no adequate seed program running there is no organization either to collect breeders' rights. This lack of incentive for breeders may hamper the introduction of new Mexican varieties. What further hampers the widening of the potato genetic pool of Mexico is the restriction on the introduction of e.g. European varieties, because of existing reluctance on both sides. The Mexican system is now based on current varieties without breeders' rights being paid and expects complications and loss of autonomy from payments of dues. European and other breeders are reluctant to introduce their varieties for fear of unrestricted multiplication in the country without dues paid to them.

2.3.2. Seed production

The introduction to the market of new varieties is mainly through the breeding work of INIFAP (South American material) and the selection work of PICTIPA (North American selections). At present no breeders' rights are paid by fresh potato growers and release to growers is slow. This is the main reason of the very small genetic base especially considering the wide variation in production environments in the country.

Sabritas produces 5 million minitubers from 1.2 million plantlets then G1, G2 and G3 that is planted and its crop (yield of G4) is processed.

Although the seed supply chain for Sabritas is well organized, it depends entirely on only a few seed growers which carries a certain risk.

The seed potato industry for the fresh market theoretically and potentially has a minituber capacity of 15 million minitubers and delivers G1-G5. In practice less than 5 % of the growers buy certified seed and rather resort to the unofficial (informal) seed market
The informal seed supply system for table potatoes has three main components:
1. Large farmers in the North produce their own seed for producing table potatoes in the different seasons
2. Large farmers in Sonora, Sinaloha and Chihuahua sell small potatoes as seed to farmers in Central Mexico since in the North the incidence of Purple Top is much less than that in Central Mexico
3. Traders visit potato growers in the North to identify reasonably healthy crops (scouting), and purchase part of the harvest to be sold as seed to customers (table potato growers) elsewhere

Due to the flows of informal seed, diseases and pests are spread throughout the country, particularly nematodes, viruses and bacterial diseases. Since most of the growers in the North are also using informal seed (from their own multiplication), the overall quality of informal seed is gradually declining. The growers in Central Mexico are most affected by this situation since they cannot use their own small tubers as seed for planting their next crop. The reasons are the high incidence of purple top (infected tubers will not sprout) and the high incidence of nematodes and virus, both resulting from intensive cropping.

A more organised system for national seed supply, including identification of seed production areas, restricted planting dates per zone, export policies between states, and increased seed quality control has been proposed to SAGARPA but due to different interests of different types of growers nothing has been implemented.

As a result of this situation it is not surprising that in the ranking of priority issues for the different states (Annex 5), seed is listed as priority number one for all states where potatoes are produced.

2.4. Field observations

2.4.1. Table potato crops

Some observations in the field of Toluca Valley early table potato crops (May 2007, San Juan de la Huerta) and late table potato crops (August 2007 Providencia)

Three day excursions were made with growers and industry representatives to potato fields in various valleys in the Toluca area. The following observations were made:

- a virtual monoculture of potato in spring in some valleys is followed by a cereal crop in summer: every year, however potato occurs once in the same field
- there was a very irregular stand of the crops with differences between plants due to physiological age and diseases and between rows because of variation in (hand applied) fertilization between rows
- severe hail damage on leaves and stems; the damage, however varied according to age of the crop, fertilization level (as deducted from canopy color) and variety with erect ones suffering less
- crops did not reach 100 % ground cover in any case although differences between crops of the same age were evident. Growers assured us that summer crops are more prolific which indeed was observed.
- well fertilized crops apparently (masked symptoms?) had 50 % virus and yellowish nitrogen deficient and maturing crops showed almost 100 % virus and purple tops
- some fields had yellow stick traps to monitor paratrioza and psillids. It was not made clear if and how information is derived from it and if it yields consequences regarding pest control regime.
- between 1-10 % of the plants showed purple tops and 5-20 % of the plants. Very intensive frequency. Here seed comes from Sinaloa and Sonora (1400 km distance)
- Varieties observed: Fianna, Gigant, Alpha and Adora, one or two generations earlier from Canada. Price in Providencia 600 USD/t.
- Wild species – devoid of late blight – observed: *Solanum demissum* and *Solanum edinensum*.
- Yield expectation in Providencia: 35 t/ha in 100 days.
- were missing; upon digging typical purple top seed tubers were observed with thin sprouts that never emerged
- in August in Providencia one field was 100 % infected by purple top showing severe symptoms.
- typical sizes of the fields were between one half and two hectares, well managed with adequate spacing, hilling and weed control. Most of the potato related managerial actions were carried out by man or animal

Providencia (August) better fields regarding seed health and uniformity. Also management and stand. Striking that every 3-4 days a mix of fungicide and insecticide (against paratriosa) is being applied

2.4.2. Processing potato crops

Some observations in the fields of Chihuahua and Monterrey (La Solidad) potato crops (August 2007).

General

Potato production in the northern part of the country mainly takes place for the processing industry. Her flat areas under pivot irrigation assure large quantities of homogeneous raw material. Spreading planting and harvesting within and between coastal highland (Los Mochis, winter spring) and inland highland (Chihuahua) assures constant influx of fresh raw material. The flow is further leveled by storage, about 60 000 t in Los Mochis for up to 5 months

and about 20 000 t in Chihuahua for up to 3 months. Crops observed in Chihuahua were relatively devoid of seed borne pathogens and seeing the homogeneity of most fields also were derived from good seed from the point of view of physiological age at planting. Seed for chips stock often was 2nd or 3rd generation from Canadian Elite 3. We visited the fields early August and observed fields between mid stage and harvest. Regarding sustainability, besides the points raised below, the very high intensity of the use of pesticides such as insecticides against paratriosas (psillids) and tuber moth and fungicides against late blight – coupled with drift associated airplane application - are reason of environmental concern and means of rationalization need to be looked into.

Seed rate

The planting pattern is 92 x 25 cm and seed pieces on average weigh some 120 g. This leads to seed rates of about 5.5 – 6.0 t/ha. With yields of – say – 40 t/ha a multiplication rate of about 7 is achieved. This is far lower than e.g in the Netherlands where 2.0 to 3.0 t of seed is planted and 50 t/ha is yielded: a multiplication rate of about 20. The very high seed rate and associated cost in Chihuahua need attention: why and possible avenues of reduction of seed costs.

Seed price

Seed imported from Canada costs about USD 300 per t. The raw material delivered to the factory fetches about 300 USD/t. This seems to justify the question why not import probably cheaper ware potatoes from Canada and ship it to the factories. This hypothesis is for discussion only and meant to avoid or justify inefficiencies in the system.

Low solids (dry matter concentration (DMC)

The solids are lower than ideal for crisp making (about 18 %, whereas in e.g. Europe 22 is normal). There are several reasons for the low solids observed:

- the DMC is positively correlated to the length of the tuber bulking period. The latter is much shorter in Mexico with a length of the growth cycle of bout 105 days against 155 days in e.g. northern Europe
- many soils are very light (sand) which also leads to lower DM than heavier more clay containing) soils
- many crops are over-irrigated, especially when intermittent rains are not taken into account. This leads to high water content prior to harvest which increases the tuber water content too. Most fields visited showed tubers with swollen lenticels indicative of too high soil moisture content
- even after the second half of the growing season many growers still apply nitrogen and even potassium. In this late stage of growth additional N and K increase the tuber water concentration but do not lead to increased total dry matter production. It is suggested that it be tested that all K be applied before planting and all N before the middle of the growth cycle.
- Another reason for low solids is the high soil water content at harvest combined with chopping of the foliage while keeping the system root-below-ground stem-tuber intact. Hereby the water content of the tuber

may still increase thereby reducing the dry matter concentration. This may be avoided by haulm-pulling rather than haulm-chopping.
- At high soil temperatures between 25 and 30 degrees as observed the tubers after haulm killing will respire (thus loose dry matter) at a very high rate compared to low temperatures. The shorter the period between haulm killing and harvest/processing the higher the solids will be.
- Higher (average) temperatures during tuber bulking lead to lower dry matter concentrations. During mid-summer the average day/night temperatures (30/20 C) are well above optimal for dry matter concentration. Finding cotton and potato in adjacent fields seems indicative of the sub-optimal situation for both or one of the crops.
- In La Soledad very severe symptoms of deficiency of one or more minerals (Na?, Mg?, Fe?) were found. This may be due to deficiency in the soil or because the high pH (over 8.0) binds some essential mineral(s). Testing leaf concentration is recommended as well a lowering the pH in the seed furrow by application of acidifying nitrogen fertilizers and testing the acidifying effect of pure sulfur.

3. Suggestions for improvement

3.1. Table potatoes

Table potato growers' main concerns are the availability of good seed potatoes and pests (Paratrioza) and diseases (late blight). The main quality constraint of the seed for table potato crops is non-germination with lacking plants after emergence in the field at levels between 30 and 80 %. This is caused by purple top induced by a mycoplasm (phytoplasm) transmitted by paratrioza (psillids). As an 'insurance' growers spray these crops every other few days with insecticides and fungicides. As a result psillids have developed resistance against current insecticides, their natural predators are killed and the use of fungicides against late blight also kills fungi that otherwise may have affected psillids under natural conditions. Hence the following is proposed:

- improved control of psillids by an adequate alternation of insecticide types
- improved control of psillids by assuring that all potato leaves are touched by the spray; also the lower leaves and the lower surface of the leaves by specially developed whirling sprayer equipment
- comparing the resulting seed tubers from this crop with tubers from current practice regarding sprouting and emergence when used as seed in a subsequent season

Many other factors that negatively affect the seed supply chain in table potato production such as lack of seed quality control, little information on reliable seed sources, the difficulty in interstate seed transport, the difficulty (or impossibility) to introduce new varieties into the country need to be addressed at the institutional level and are not suitable issues for a pilot.

3.2. Processing potatoes

Data mining

The amount of data that are being gathered is considerable. Factories know the origin of the raw material increasingly accurately and with growers determining the quality per truck load (defects, DMC, fry colour) the amount of data increases even more. It offers the possibility to benchmark qualities against each other and to correlate quality (e.g. sugars, fry colour, DMC) to e.g. moment of harvest, amount of nitrogen or water supplied, average temperature during tuber bulking and so on and so forth.

Stem wet rot

In many fields severe stem wet rot (Erwina carotovora and E. Chrysanthemi) symptoms (wilting plants in wet soil and black rotten stem parts) were observed, certainly leading to severe yield reduction and possibly yield losses due to rotten tubers upon harvest. The cause is high temperatures and high soil moisture. The bacteria enter the plant through swollen lenticels in tubers and stem base and cause stem and potentially tuber rot. Spread from one plant to the other (we observed one pivot with 99 % infection) is from plant to plant, splashing rain water, aerosols and contaminated insects. Heavily infected fields cannot be used for further seed production and harvested potatoes have reduced storability.

Irrigation management

Most fields visited were too wet from irrigation and rainfall. The practice of irrigating standard every 4 days with 20 mm water irrespective of evaporative demand (weather and crop cover) and rainfall leads to over-irrigation with the following disadvantages:

- high costs of irrigation (electricity)
- too rapid and unnecessary depletion of available soil water
- leaching of nutrients
- too low solids
- diseases such as caused by Erwinia spp.

Fertiliser management

Reportedly NPK fertilization is based on soil sampling and recommendations. The following observations apply:

- the recommendations should reflect the attainable yields in Chihuahua (say 40 t/ha and not those of Idaho with much higher yields
- apply all K at planting (otherwise it will negatively affect DMC)
- apply all N before the second half of the growing season (otherwise it will negatively affect DMC).
- Test deficiency symptoms and reduce pH in plant environment

Hilling

Most fields (especially those with sandy soils) hardly showed any ridge anymore. This has two negative consequences:

- greening and or rotting (due to scalding) of superficial tubers
- water logging leading to tuber rot (Erwina)

It is suggested to level fields and make sure no lower lying parts exist, where they do assure the presence of drainage ditches.

3.3. Special attention needed for purple top

Obviously purple top is the potato disease that causes major concern as its incidence is becoming more widespread and more frequent. Questions that need to be resolved:

- Why has it become so important?
- What is the relation with phytoplasma?, apparently often symptoms occur without a detected presence of phytoplasma
- What is the source of inoculum?
- The vectors are leafhoppers and psillids like *Paratrioza cockerelli,* can we control them, do pheromones exist?
- Why do emerged plants from seed of infected mother tubers not (always) present symptoms?
- Is there interaction with other diseases (Fusarium was suggested)
- Is resistance of genotypes related to lateness as is the case with late blight?
- What are all components of an integrated control approach?
- Can Mexico benefit from the USA (Lays-Dalls) experience?
- -

An extensive discussion regarding Purple Top and ongoing activities in the USA took place with Gerhard bester of Fritolay in Dallas in the few days following the May-trip to Mexico. There is a need, however, to make purple top a topic of the foreseen pilots to improve the quality of seed potato for the table market and to improve the quality of processing potato (reduce the occurrence of zebra chips).

4. Workplans 2008/2009

These will be based upon the suggestions mentioned in Chapter 3 and are going to be defined and finalized in December 2007 and January 2008 by e-mail .Possible contributions to work carried out in 2008 of the various actors in the potato supply chain as discussed during the plenary sessions and individual meetings.

Actor	**Contribution**
Potato growers	Field trialing tools, data collection
Universities	To be decided
Colegio Postgraduados	Thesis of students, technology for DSS, organic farming
INIFAP	Test known technologies under local conditions
Potato Production System	Diffuse results, involvement of other chain actors
Conpapa	Identify actors, diffuse results
Industry	Facilitation, lab analysis (soil, diseases), technical consultancy
Wageningen UR	Coordination, technology, tools, exchange of students, growers
Suppliers	*PM*
Mexican Government	*PM*

Annex 1

Schedule of visits

a) First trip (Haverkort & Wiersema)
Facilitated by Newton Yorinori

May 1st, (Tuesday) Arrival in Mexico

May 2nd (Wednesday)
08:15 hs : Pick up @ Hotel Del Rey Inn and transportation to Sabritas Agro R&D Facility
09:00 – 14:00 hs: Meeting with Sabritas
14:00 – 15:00 hs: Lunch
15:00 – 18:00 hs: Meeting with Conpapa

May 3rd (Thursday)
08:15 hs : Pick up @ Hotel Del Rey Inn and transportation to Sabritas Agro R&D Facility
09:00 – 11:00 hs: Meeting with Colegio de Pos Graduados
11:00 – 14:00 hs: Meeting and visit to INIFAP
14:00 – 15:00 hs: Lunch
15:00 – 18:00 hs: Visit to Villarreal Greenhouses (Mini tuber production)

May 4th (Friday)
08:15 hs : Pick up @ Hotel Del Rey Inn and transportation to Sabritas Agro R&D Facility
09:00 – 12:00 hs: Workshop with all companies and institutions and wrap up session
13:00 -19:00 hs: Field visits in the Toluca area with CONPAPA and Mexico State Potato Producers organization

May 5th (Saturday)
Bus trip Toluca Mexico City Airport, Departure to Netherlands arrival May 6th.

b) Second trip (Haverkort) (4000 km by plane and 2000 by road)
Facilitated and accompanied by Hugo de Alba and Arturo Barbosa

August 5th (Sunday) Arrival in Mexico

August 6th (Monday)
Morning: meeting at the Netherlands Embassy (de Rijk, de Alba, Barbosa, Ortiz)
Afternoon: meeting with Arturo Duran (Sabritas Mexico City Headquarters)

August 7 (Tuesday)
- Early morning: meeting with CONPAPA and Sabritas on objectives and responsibilities
- Day: visit of fields, fact finding, quick scan with Dr. Oswaldo Rubio (Inifap) and Mrs Guadelupe Ramirez (Sistema Producto Papa) in Toluca area Ramira and Gabriel Garcia in the village of Providencia.
- Evening: flight to Chihuahua

August 8 (Wednesday) with HdA and AB
Field visits in Chihuahua State: Growers Erneste Ortegon (seed and ware) and Agro-Horizontes in Santa Rosa, producers for Sabritas

August 9 (Thursday) with HdA and AB
Field visits Chihuahua: Agro-Horizontes and Casa Grandes, producers for Sabritas

August 10 (Friday) with AB
Early morning: Flight to Monterrey
Day: field visits in La Solidad Agro-Jaba and Villareal
Evening: Flight to Toluca

August 11th (Saturday)

- Morning: discussion of programme and venue national seminar with Manuel Villareal (CONPAPA) and Hugo de Alba and Arturo Barbosa (Sabritas)
- Bus trip Toluca Mexico City Airport
- Departure 19:00 to the Netherlands (arrival August 12th.)

c) Third trip (Haverkort & Wiersema)
November 11-14: planning 2008 pilots with INIFAP and Sabritas

Annex 2

Key Persons met

CONPAPA:	Manuel Villareal (sr), Manuel Villaverde
Coll. de postgraduados :	Manuel Sandoval, Promoteo…..
Mex. St. Producer Organ :	Guadelupe Ramirez
INIFAP:	Humberto Lopez, Oswaldo Rubio, Telesforo Zavala, Antonio rivera, Carlos Diaz,
PICTIPAPA …university:	Hector Loyoza
Sabritas:	Newton Yorinori, Hugo De Alba, Arturo Duran, Arturo Barbosa, Guillermo Ortiz
Growers:	Aurelio Arriage, Diogenes Huerfano,
Minituber producer:	Manuel Villareal
Wageningen, Netherlands:	Anton Haverkort, Siert Wiersema
Netherlands Embassy:	Pieter de Rijk

Annex 3.Noted exclamations!

The present report is based on written or reported facts and figures. During the various interactions heartfelt opinions were ventilated occasionally without scientific or quantitative background being supplied. They are reproduced here as ammunition for the description potential pilots.

- a grower: I spray 20 x with a mixture of insecticides and fungicides but feel that control of both insects and late blight is becoming less effective over the years!
- an opinion leader: ever more new chemicals (pesticides) come the market rather than modern ones replacing the old ones
- many persons: varieties bred in Mexico do not reach the growers because there is no incentive for breeders
- a leader: diseases like *spongospora* and ringrot were introduced from Canada, we should be careful when introducing seed potatoes from abroad
- a scientist: new varieties may be grown at lesser costs as they may represent better adaptation to prevailing conditions, higher levels of resistance and better quality such as a higher rate of recovery in processing. They thus contribute to sustainability
- a farmer: we should go back to the early system of moving seed from high to lower lands
- highland seed production areas should widen their rotation (often monocultures now)
- farmers and scientists: due to present year round production in Mexico State, pests cycles are not interrupted, building up pressure
- a representative of the industry: the environment changed due to climate, erosion, biodiversity and disappearing natural enemies
- a scientist: hydrogen peroxide and salicyl acetatic acid applications can boost tolerance of purple top, drought and lack of nutrients
- farmers: new varieties of INIFAP do not reach the growers yet we do need new adapted and resistant varieties urgently
- a scientist: there is a lack of technology transfer from science to growers due to absence of an extension service
- a representative of the industry: the main source of information on the use of chemicals is from the chemical companies which may be responsible for over use
- a scientist: can the Mexican situation learn from other countries how they commercialize seed and especially also table potatoes?

Annex 4. Suggested programme of the 2008 national seminar

Title: Sustainable potato production in Mexico: issues and actions.

Conveners:
- CONPAPA
- Sabritas
- Netherlands Embassy

Location:
- Ministry of Environment Mexico City, SEMARNAP

Invitees:
- Sagarpa, Semarnap, Sabritas,Conpapa, NL-Embassy, Waeningen UR
- Cofupro, Inifap, Senasica, Universidades, Sistema de production
- Amival, Nappo, Eppo, Centrales de Abasto

Agenda:

Morning:
- opening address Conpapa
- sustainability global concepts (Wageningen?)
- sustainability Mexican context (any Mexican commodity example)
    - Seed/variety casus
    - Fertility and water casus
    - Purple top casus
- discussion
- nutritional break and departure of those not taking part in afternoon round tables

Afternoon:
- three round tables on
    - Seed/variety casus
    - Fertility and water casus
    - Purple top casus
- plenary reporting of work plans and deliverables
- final conclusions and commitments
- drinks and farewell

Annex 5

Issues per region in descending order of importance, beside market which is priority number 1 in each region

North West *Sonora, Sinaloa*	**North East** *Coahuila Nuevo Léon*	**Central** *Puchla Mexico Tlaxcala Veracruz*	**North** *Chihuahua*	**Lower** *Michoacan Guanajuato*
Seed	Seed	Seed	Seed	Seed
Bacterial diseases (Ral, Erw)	Purple top	Purple top	Soil fungi	Purple top
Soil fungi	Soil fungi Fusarium, Verticillium)	Late blight	Bacterial disease (Ralstonia)	Tuber moth
Mineral nutrition	Late blight	Soil fungi	Tuber moth	Soil fungi
Water (management)	Water (Lack of)	Nematodes		Bacterial diseases
				Mineral nutrition