Mexican protected horticulture

Production and market of Mexican protected horticulture described and analysed

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Referaat

Deze studie beschrijft en analyseert de Mexicaanse bedekte tuinbouwsector, die zich sterk ontwikkelt, en daarmee een relevante partner voor de Nederlandse toeleverende industrie is. De sector is geografisch over het grote land verspreid, en wordt gekenmerkt door een grote variatie in technologisch niveau. De export naar de VS en Canada zijn belangrijk voor de ontwikkeling van de groentesector. Moment van productie, logistiek, kwaliteit en traceability, kostenreductie en samenwerking zijn essentieel. De sierteeltsector kan niet met andere Latijns Amerikaanse landen op de exportmarkt concurreren, en zal sterk afhankelijk zijn van de nationale situatie. Hardware, kennis, infrastructuur, en samenwerking zijn enkele verbeterpunten. De Nederlandse tuinbouwindustrie is leidend en levert hoge kwaliteit producten en diensten. De voor de hand liggende markten in Mexico voor Nederlandse leveranciers liggen op het midden- en hoogtechnologische niveau. Het meest interessant zijn:

1. Kleine tot middelgrote (0,5 tot 2 ha) groentebedrijven die zich hebben geclusterd.
2. Kleine tot middelgrote bloemen- en sierplantenbedrijven die goede variëteiten nodig hebben.
3. Middelgrote tot grote groentebedrijven in verschillende gebieden die met maatwerk vooruit geholpen kunnen worden.
4. Middelgrote tot grote snijbloembedrijven in Baja California die naar de VS exporteren.
5. Agroparken.

Abstract

This study describes and analyses the strongly developing Mexican greenhouse horticultural sector, which is a relevant partner for the Dutch supply industry. The sector is geographically spread over the large country, and characterized by wide variation in technology level. The export to the USA and Canada is relevant for the development of the vegetable sector. Timing of production, logistics, quality and traceability, cost reduction and cooperation are essential. The ornamental sector can not compete with other Latin American countries on the export market, and will largely depend on the domestic situation. Hardware, knowledge, infrastructure, cooperation are some of the issues. The Dutch horticultural industry is world-leading and supplies high-quality products and services. Therefore, the obvious markets for Dutch suppliers in Mexico are formed by the medium and high-tech sectors. Most interesting are:

1. Small to medium scale (0.5 to 2 ha) vegetable farms that have formed clusters.
2. Small to medium scale flower and ornamental farms that need good varieties.
3. Medium to large vegetable growers in various regions can be assisted in their advancement through a tailor-made approach.
4. Medium to large-scale cut flower farms in Baja California that exporting to the USA.
5. Agroparks.

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Acronyms

AMCI	Asociación Mexicana de Constructores de Invernaderos / Mexican Association of Greenhouse Builders
AMHPAC	Asociación Mexicana de Horticultura Protegida / Mexican Asociation of Protected Horticulture
ASERCA	Apoyos y servicios a la comercialización agropecuaria / Funds and Services for the agricultural Commercialisation
CIDH CAADES	Comisión para la Investigación y Defensa de las Hortalizas / Commission for the investigation and defence of vegetables
CONACYT	Consejo Nacional de Ciencia y Tecnología / National Science and Technology Board
EL&I:	Ministerie van Economie, Landbouw en Innovatie / Dutch Ministry of Economics, Agriculture and Innovation
FIRA	Fideicomisos Instituidos en Relación con la Agricultura / Instituted Trust Funds for Agriculture
FOCIR	Fondo de Capitalización e Inversión del Sector Rural / Capitalization and Investment Fund for the Rural Sector
INTAGRI	Instituto para la innovación tecnológica en la agricultura / Institute for Technological Innovation in Agriculture
NAFTA	North American Free Trade Agreement
SAGARPA	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación / Mexican Secretary of Agriculture, Livestock, Rural Development, Fishery and Food
SIAP	Servicio de Información Agroalimentaria y Pesquera / Agricultural and Fishery Information Services

Summary

The Mexican horticultural sector is strongly developing in a global setting. This makes Mexico a relevant partner for the Dutch supply industry that, however, has to compete with suppliers from other countries such as US, France and Israel.
Available information on the Mexican horticultural sector is out-dated, incomplete, and not always reliable. An accurate and actual description of various market segments does not exist. Therefore, an assessment of the Dutch competitiveness on the Mexican market can not be reliably produced, and a strategy to increase Dutch competitiveness is difficult to formulate.

The purposes of the project of which this report is the physical result were to provide:

- a detailed, accurate and actual description of the Mexican horticultural sector and its sub-sectors, in terms of crops (vegetables, flowers, bulbs, plants), acreages, production, production system, technological level, innovations, sustainability, market situation, etc.
- an analysis of the technological level that is suitable for specific production and market systems and a view on expected technological developments.
- A SWOT analysis of the Dutch supply industry and export competitiveness, also in comparison to other suppliers to the high and medium-tech Mexican horticultural sector.

The results of this study, elaborated by means of interviews with representatives of the industry and based on data collected by different governmental organizations and associations, are summarized here.

Regional spread: Greenhouse horticulture is wide-spread over Mexico, and knows a wide diversity of crops. 60% of the acreage is concentrated in 5 states, viz. Sinaloa, Baja California, Baja California Sur, Jalisco and Mexico. Strongest growth is taking place in Sinaloa, Jalisco, Guanajuato and Michoacán. Queretaro is important for its agropark. Tomato is by far the most important horticultural crop, to which 50% of the acreage is allocated. Cucumber, peppers, and eggplants follow. Berries are gaining importance. Mexico and Morelos are the most important states for the production of flowers, and potted plants, although some ornamental production is wide-spread over the country.

The international market: Relevant for the development of the vegetable sector is the export to the USA, and to some extent Canada. Mexico can compete on the basis of increased consumption in the USA and Canada and timing of production. Good logistics, quality and traceability are essential, as is cost reduction. Cooperation in the sector will be increasingly important in the future to remain competitive.

The domestic market: The ornamental sector will largely depend on the domestic situation. With some exceptions, it is not feasible to compete with other Latin America countries in the field of cut flowers. Their quality and logistics is superior. It will require very large steps to develop an industry-type of ornamental industry that can compete internationally. Hardware, knowledge, infrastructure, cooperation are just some of the issues.

The Netherlands can assist in many of these issues. The Netherlands has wide experience in setting up production facilities, farmer and sector organization, marketing, post-harvest management, and many other issues. The question, however, is whether the Mexican sector is willing to invest in this involvement as long as the domestic market is easily absorbing the production.

Levels and transition in technology: The stratification of technology levels in low, medium and high is often used in the Mexican context. The advantage is that at first glance, communication and understanding are simplified. It carries some serious dangers, however. The two most important ones are:

- Definitions vary which causes unreliable analysis and decision-making.
- It ignores complex transition processes that work more at the level of modules than entire systems.

Both aspects can negatively affect issues such as the detail of the analysis, prioritization, decision-making, and design of future systems. A greenhouse owner will normally not move from medium to high-tech in one large step, but successively up-grade components of his greenhouse. It is important then to maintain the balance of the components.

These processes are probably well-understood by most entrepreneurs in the horticultural supply industry, but may prove a hurdle for cooperation in a competitive market. The factors that influence decision making at the component-level are probably market-related, but are not fully understood. The Dutch horticultural industry is world-leading in supply of all components. Constructions, installations, knowledge, logistics, organization structures are some of the Dutch competences. Given the fact that horticulture in The Netherlands is state-of-the-art, The Netherlands supplies high-quality products and services. Therefore, the obvious markets for Dutch suppliers in Mexico are formed by the medium and high-tech sectors, which comprise a mixture of medium and high-tech components. With Dutch involvement, medium-tech components can be replaced by more-high-tech components, and high-tech components can be replaced with higher-tech components.

If everything is put together, we conclude that the following is of most interest to Dutch industry:

6. Small to medium scale (0.5 to 2 ha) vegetable farms that have formed clusters for commercialization of their produce. Dutch experiences in organizing farmers for the market, e.g., examples of collective bulking, grading and development of niche markets by farmer organisations, gives Dutch industry a comparative and marketable advantage
7. Small to medium scale flower and ornamental farms in the central states of Mexico and Morelos need for good varieties, which offers opportunities for suppliers of young plants.
8. Medium to large vegetable growers are a very attractive group for Dutch involvement. A tailor-made approach that focuses on relevant modules of greenhouse horticulture can help them advance. Vegetable farms are developing in Central and Western States of Mexico (Jalisco, Michoacán), mainly producing for domestic markets but with the potential to engage in export markets. Depending on current market position and network, and because of the size of the segment, they represent the main potential for technology development. Vegetable farms in the northern states of Mexico (Sonora, Sinaloa) have an already established track record in exporting and are further innovating. They expect technology input suppliers to support them in finding the right product-market combination with best-fit technology. Vegetable growers in Baja California North and South and in Sonora-Sinaloa have a low level of technology but a good exporting record, and require good quality seed and plant material. Newly established vegetable farms in Durango, Chihuahua, Coahuila, San Luis Potosí, and Nuevo León are export-oriented may require a technological upgrade by the Dutch supply industry.
9. In cut flowers, medium to large-scale farms are found in Baja California exporting to the Californian market. Development demands are unknown. This group is of interest to Dutch industry, and is best assisted in an integrated approach.
10. Agroparks are large agro-industries (> 10 ha) that share physical space and infrastructure and operate either independently or in integrated market chains focussing on the export market, mainly the USA and Canada. Interesting for Dutch industry for development of integrated concepts requiring innovative and higher investments. Dutch involvement must be through an integrated approach.

Recommendation. On the basis of discussions with various representatives of the Mexican industry, a series of recommendations can be defined.

1. Re-define the term “High-Tech”
    a. Do not associate it with glass cover
    b. Separate the greenhouse construction from the greenhouse installation.
2. Keep on improving ‘High-tech’: it is not a static concept, but should benefit from latest technological developments.
3. Incorporate “high-tech elements” in mid-tech greenhouses, especially that increase sustainability
    a. Re-use drain water
    b. Integrated pest management
    c. Heating by means of solar radiation
4. “Tropicalize” Dutch technology
5. Demonstrate the technology under local conditions
6. In Mexico, price counts
7. In Mexico, personal contact count
8. Market focus
9. ADAPT, not ADOPT; “The adaptive greenhouse”

Resumen

El sector de la horticultura protegida mexicana experimenta un fuerte desarrollo a todos los niveles. Esto convierte a México en un importante interlocutor para la industria holandesa de los suministros e insumos hortícolas, quien se ve obligada a competir con suministradores de otros países bien establecidos en México como es el caso de EEUU, Francia e Israel.

Para poder elaborar un análisis de la posición competitiva de la industria holandesa se necesita información sobre el sector de la horticultura Mexicano. La información existente no está lo suficientemente actualizada, es incompleta y no siempre fidedigna, por lo que se hace muy difícil formular una estrategia para aumentar la competitividad de la industria suministradora holandesa.

Mediante el presente proyecto, del cual este informe es el resultado, hemos intentado proporcionar:

- Una descripción lo más detallada, precisa y actualizada posible de la horticultura Mexicana y sus subsectores, en cuanto a cultivos, (hortalizas, flores, bulbos, planta ornamental), superficie, niveles y sistemas de producción, nivel de innovación, sostenibilidad, situación comercial, etc.
- Un análisis del nivel tecnológico vigente y adecuado para los sistemas de producción y comercialización existentes, y una visión sobre los desarrollos tecnológicos que cabe esperar.
- Un análisis de fortalezas y debilidades de la industria suministradora holandesa y su posición competitiva con respecto a otros suministradores del sector tecnológico medio y alto mexicano.

Los resultados de este estudio, principalmente elaborado en base a entrevistas con individuos representates del sector y en base a datos recopilados por diversos organismos gubernamentales y asociaciones, se resumen a continuación.

Distribución regional: La horticultura protegida se encuentra ampliamente extendida por todo el país y abarca una gran diversidad de cultivos. El 60% del areal se concentra en 5 estados principales: Sinaloa, Baja California, Baja California Sur, Jalisco y México. El mayor ritmo de crecimiento se da en Sinaloa, Jalisco, Guanajuato y Michiocán. Querétaro es importante porque alberga el primer “Agroparque”. El cultivo más importante es el tomate o jitomate, al cual está dedicada la mitad de la superficie de cultivo bajo protección. El cultivo del pepino, el pimiento y la berenjena gana terreno rápidamente. El cultivo de las bayas o frutas blandas (fresón, frambuesa, zarzamora, arándano…) gana importancia. México y Morelos son los estados más importantes en lo que respecta al cultivo de flores y planta ornamental respectivamente, aunque puedan encontrarse ornamentales por todo el país.

El mercado internacional. De importancia para el desarrollo del sector de la hortaliza es la exportación a los EEUU, y, en menor grado, a Canadá. México puede competir con la producción interna de ambos países basándose en un aumento del consumo por parte de EEUU y Canadá, así como en su buen cronometraje de la producción. La buena logística, calidad y trazabilidad, así como la reducción de costes son esenciales. La cooperación dentro del sector seguirá ganando importancia en el futuro para mantener la competitividad.

El mercado nacional. El sector ornamental seguirá dependiendo en gran medida del mercado doméstico. La competencia con otros países latinoamericanos exportadores de flor cortada no es viable (salvando las excepciones), ya que éstos han desarrollado una gran ventaja logística y de calidad. Se necesitan grandes avances (en hardware, conocimiento, infraestructura y cooperación, por nombrar algunos ejemplos) para desarrollar una industria ornamental capaz de competir internacionalmente.
Holanda puede apoyar este avance en cuanto a los aspectos mencionados, ya que cuenta con gran experiencia en la construcción de instalaciones productoras, en la organización sectorial y de cultivadores, en promoción y comercialización, en manejo post-cosecha, y en muchos otros aspectos. Sin embargo, no es evidente que el sector ornamental mexicano esté dispuesto a invertir en esta implicación holandesa, al menos mientras el mercado doméstico siga absorbiendo fácilmente la producción.

Niveles tecnológicos y transición tecnológica. La clasificación de los niveles tecnológicos en baja, media y alta tecnología se utiliza a menudo en el contexto mexicano. La ventaja de esta clasificación es que a primera vista, se simplifica la comunicación y el entendimiento mutuo. Sin embargo, también conlleva algunos peligros, siendo los dos más importantes:

- La definición depende del interlocutor, lo que causa análisis inexactos y toma errónea de decisiones
- La clasificación es estática e ignora los procesos complejos de transición, ya que estos obedecen a una evolución modular en lugar de a una evolución sistemática (de todo el sistema).

Ambos aspectos pueden afectar negativamente temas como el nivel de detalle de los análisis, el establecimiento de prioridades, la toma de decisiones, y el diseño de sistemas futuros. El propietario de un invernadero normalmente no cambiará su nivel de tecnología en un sólo paso, sino que mejorará componentes sucesivamente. Es importante mantener el equilibrio entre componentes. Estos procesos, probablemente bien entendidos por la mayoría de empresarios hortícolas, pueden crear obstáculos a la cooperación en un mercado competitivo. Es probable que los factores que influyen en la toma de decisiones a nivel de componentes técnicos de la unidad productiva, estén relacionados con los mercados de destino, aunque falta el entendimiento del carácter preciso de tal interdependencia.
La industria hortícola holandesa es líder mundial en el suministro de todos sus componentes. Invernaderos, instalaciones, conocimiento, logística, estructuras organizativas son algunos ejemplos. Puesto que en Holanda la horticultura es un sector puntero y altamente innovador, Holanda es capaz de suministrar productos y servicios de alta calidad. Por eso, el mercado más adecuado para la industria suministradora holandesa lo forman las empresas interesadas en tecnología alta y media, que comprenden una mezcla de components clasificables en ambas categorías. Con la participación holandesa, componentes de tecnología intermedia pueden ser reemplazados por componentes de alta tecnología, y éstos a su vez por componentes de tecnología superior.

Recapitulando, podemos concluír que el mayor interés para la industria holandesa lo forman:

1. Explotaciones pequeñas o medianas (0.5 a 2 ha) productoras de hortalizas agrupadas para la comercialización de sus productos. La experiencia holandesa en la organización de productores para el mercado, proporciona a la industria holandesa una ventaja comparativa y comercializable.
2. Explotaciones pequeñas o medianas productoras de flores y planta ornamental en los estados centrales de México y Morelos requieren buenas variedades, lo que ofrece oportunidades a las empresas mejoradoras y propagadoras.
3. Las explotaciones de tamaño mediano y grande forman un grupo muy atractivo para la participación holandesa. Un enfoque modular a medida de los componentes de un invernadero pueden ayudarles a avanzar. Empresas de hortalizas de estas características se están desarrollando en los estados centrales y occidentales de México (Jalisco, Michoacán), principalmente produciendo para el mercado nacional pero con potencial suficiente para comprometerse con mercados de exportación. Dependiendo de su actual posición comercial y su red de contactos, y debido al tamaño del segmento, representan el mayor potencial para el desarrollo tecnológico. Productores de hortalizas en los estados del norte de México (Sonora, Sinaloa) ya se han establecido y tienen un amplio historial en los mercados de exportación y continúan innovando. Confían en la industria suministradora para que les ayude a encontrar la combinación ideal entre su mercado-producto y la tecnología que major se adapte a su situación. Productores de hortalizas en Baja California Norte y Sur así como una buena parte de Sonora-Sinaloa tienen un nivel tecnológico bajo, pero un buen historial exportador, y requieren semilla y planta joven de buena calidad. Explotaciones de reciente creación en Durango, Chihuahua, Coahuila, San Luis Potosí y Nuevo León son orientadas a la exportación y pueden ser susceptibles a avances tecnológicos ofrecidos por la industria holandesa.
4. En flor de corte, plantaciones de tamaño medio-grande se encuentran en Baja California exportando hacia el mercado Californiano. Sus requisitos para el desarrollo no han sido dilucidados en este estudio. Este grupo es interesante para la industria holandesa y se sirve de la forma más adecuada mediante un enfoque integrado.
5. Agroparques son industrias agrícolas de gran tamaño (> 10 ha) que comparten un espacio físico e infraestructura, pero operan bien independientemente, bien en cadenas comercializadoras integradas enfocadas hacia el mercado de exportación, principalmente los EEUU y Canadá. Interesantes para la industria holandesa para el desarrollo de conceptos integrados que requieren mayores inversiones e innovación. La participación holandesa debe seguir un enfoque integrado.

Recomendaciones. En base a las entrevistas realizadas con representantes de la industria Mexicana, se pueden destilar algunas recomendaciones:

1. Re-definir el término “Alta tecnología”
    a. Que no se asocie con una cubierta de vidrio
    b. Que se separe la estructura del invernadero y la cubierta de las instalaciones internas.
2. Continúe mejorando la Alta Tecnología, puesto que no se trata de un concepto estático y puede por tanto beneficiarse de los más recientes desarrollos tecnológicos.
3. Incorpore “elementos de alta tecnología” en invernaderos de “tecnología media”, en especial aquéllos que aumentan la sostenibilidad económica y medioambiental, como:
    a. Sistemas de reutilización del agua de drenaje
    b. Lucha integrada de plagas
    c. Calefacción mediante energía solar
4. Hay que “Tropicalizar” la tecnología holandesa, es decir, adecuarla a la situación mexicana
5. Nuevas tecnologías deben demostrarse bajo las condiciones locales.
6. En México, el precio es importante
7. En México, el contacto personal es importante
8. Oriente el sistema de producción al mercado al cual se dirige,
9. ADAPTE, pero no ADOPTE los productos y servicios holandeses

Samenvatting

De Mexicaanse tuinbouwsector ontwikkelt zich snel binnen een globale setting. Dit leidt er toe dat Mexico een relevante partner is voor de Nederlandse toeleverende industrie, die echter moet concurreren met toeleveranciers van andere landen zoals de VS, Frankrijk en Israël. Beschikbare informatie over de Mexicaanse tuinbouwsector is verouderd, incompleet en niet altijd betrouwbaar. Een betrouwbare en actuele beschrijving van de verschillende marktsegmenten is niet beschikbaar. Daarom kan een goede bepaling van de Nederlandse concurrentiekracht op de Mexicaanse markt niet worden gegeven, en is een strategie om de Nederlandse concurrentiekracht moeilijk te bepalen.

De doelstellingen van het project, waarvan dit rapport het fysieke resultaat is, waren het leveren van:

- Een gedetailleerde, accurate en actuele beschrijving van de Mexicaanse tuinbouwsector en haar sub-sectoren, in termen van gewassen (groenten, bloemen, bollen, planten), arealen, productie, productiesystemen, technologieniveaus, innovatie, duurzaamheid, marktsituatie, etc.
- Een analyse van de technologische niveaus die geschikt zijn voor een bepaald productie- en marktsysteem, en een visie op verwachte technologische ontwikkelingen.
- Een SWOT analyse van de Nederlandse toeleverende industrie en concurrentiekracht op exportgebied, mede in vergelijking met andere leveranciers in het hoog en midden-technologische niveau van de Mexicaanse tuinbouwsector.

De resultaten van de studie, die zijn gebaseerd op interviews met vertegenwoordigers van de industrie en op gegevens die door verschillende overheidsdiensten en organisaties zijn verzameld, worden hier gepresenteerd.

Regionale spreiding: Bedekte tuinbouw is wijdverspreid over Mexico en kent veel verschillende gewassen. 60% van het areaal ligt in 5 staten, namelijk Sinaloa, Baja California, Baja California Sur, Jalisco and Mexico. De sterkste groei vindt plaats in Sinaloa, Jalisco, Guanajuato and Michoacán. Queretaro is van belang vanwege het Agropark. Tomaat is verreweg het belangrijkste gewas, en wordt op meer dan 50% van het areaal verbouwd. Het wordt gevolgd door komkommer, paprika en aubergine. Bessen winnen aan belang. Mexico en Morelos zijn de belangrijkste staten voor de productie van bloemen en potplanten, terwijl de productie van sierplanten wijdverspreid is over het hele land.

De internationale markt: De export naar de VS, en in mindere mate naar Canada, is relevant voor de ontwikkeling van de groentesector. Mexico kan concurreren in verband met de toenemende consumptie in de VS en Canada, en in verband met het moment van productie. Goede logistiek, kwaliteit, tracing en kostenreductie zijn essentieel. Samenwerking in de sector zijn in de toekomst aan belang winnen om competitief te blijven.

De thuismarkt: De bloemensector is erg afhankelijk van de situatie in Mexico zelf. Met enige uitzonderingen is het niet haalbaar om te concurreren met anderen Latijns Amerikaanse landen. Hun kwaliteit en logistiek zijn veel beter. Het zou zeer grote stappen vereisen op een industriële bloemensector die internationaal kan concurreren, te ontwikkelen. Hardware, kennis, infrastructuur en samenwerking zijn slechts enkele van de elementen die aan bod zouden komen.

Nederland kan op veel van de genoemde gebeiden een rol vervullen. Nederland heeft brede ervaring in het opzetten van productiefaciliteiten, vermarkting, post-harvest management, en andere zaken. De vraag is echter of Mexico bereid is om in deze betrokkenheid te investeren zo lang de nationale markt de productie eenvoudig kan absorberen.

Niveaus van en transitie in technologie: De onderverdeling van technologieniveaus in laag, midden en hoog wordt in de Mexicaanse context vaak gebruikt. Het voordeel is dat, op het eerste gezicht, communicatie en begrip eenvoudiger worden. Er zijn echter ook enkele grote nadelen aan verbonden, waarvan de twee meest belangrijke zijn:

- Definities variëren, wat analyse en besluitvorming onbetrouwbaar maakt.
- Het ontkent complexe transitieprocessen die meer op het niveau van systeemmodules werken, dan op het niveau van volledige teeltsystemen.

Beide aspecten kunnen een negatief effect hebben op details van de analyse, prioritering, besluitvorming en ontwerp van toekomstige systemen. Een bedrijfseigenaar zal normaalgesproken niet in een stap van midden- naar hoogtechnologisch niveau bewegen, maar systeemcomponenten een voor een aanpassen. Het is belangrijk om de balans in de componenten van een teeltsysteem te bewaren. Deze processen worden waarschijnlijk door ondernemers in de tuinbouw onderkend, maar kunnen een hindernis blijken te zijn voor samenwerking in een competitieve markt. De factoren die de beslissingen op het niveau van componenten beïnvloeden zijn waarschijnlijk markt-gerelateerd, maar worden nog niet volledig begrepen.

De Nederlandse tuinbouwindustrie is toonaangevend op mondiaal niveau. Constructie, installatie, kennis, logistiek, en organisatiestructuren zijn enkele van de Nederlandse expertises. Gegeven het feit dat de tuinbouw in Nederland state-of-the art is, levert Nederland producten en diensten van hoge kwaliteit. Daarom zijn de midden- en hoogtechnologische segmenten van de tuinbouwsector in Mexico de voor de hand liggende markten voor Nederland. Met Nederlandse betrokkenheid kunnen middentechnologische componenten worden vervangen door meer hoogtechnologische componenten, en kunnen hoogtechnologische componenten worden vervangen door hoger-technologische componenten.

Alles overziend, concluderen we dat het volgende van meest belang is voor de Nederlandse industrie:

1. Kleine tot middelgrote (0,5 tot 2 ha) groentebedrijven die clusters hebben gevormd om hun producten te vermarkten. Nederlandse ervaring in het organiseren van tuinders voor de markt, bijvoorbeeld bijvoorbeeld door middel van gedeelde logistiek en ontwikkeling van niche markten door boerenorganisaties.
2. Kleine tot middelgrote bloemen- en sierplantenbedrijven in de centrale staten Mexico en Morelos hebben behoefte aan goede variëteiten, wat mogelijkheden biedt voor leveranciers van jonge planten.
3. Middelgrote tot grote groentebedrijven vormen een aantrekkelijke groep voor Nederlandse betrokkenheid. Maatwerk dat zich richt op de juiste modules binnen een teeltsysteem kan deze bedrijven vooruit helpen. Groentebedrijven ontwikkelen zich in de centrale en westelijke staten (Jalisco, Michoacán), en produceren voornamelijk voor de nationale markt, maar hebben het potentieel om te gaan exporteren. Afhankelijk van de huidige marktpositie en netwerk, en vanwege de omvang van de sector, vertegenwoordigen deze staten het belangrijkste potentieel voor technologische ontwikkeling. Groentebedrijven in de noordelijke staten (Sonora, Sinaloa) hebben al een historie van export en innovatie. Hier wordt verwacht dat leveranciers van technologie ondersteuning bieden in het vinden van de juiste product-markt combinaties met de beste op maat gemaakte technologie. Groentebedrijven in in Baja California North and South and in Sonora-Sinaloa worden gekenmerkt door een laag technologisch niveau maar een geode exportpositie, en hebben behoefte aan goed plant- en zaaigoed. Nieuwe groentebedrijven in Durango, Chihuahua, Coahuila, San Luis Potosí, and Nuevo León zijn exportgeorienteerd en hebben behoefte aan een technologische verbetering door de Nederlandse toeleverende industrie.
4. Middelgrote tot grote bedrijven die snijbloemen produceren bevinden zich in Baja California. Er wordt naar Californië in de VS geëxporteerd. Deze groep tuinders is interessant voor de Nederlandse industrie, en kan het best met een geïntegreerde aanpak worden ondersteund.
5. Agroparken zijn grote agro-industrieën (> 10 ha) die fysieke ruimte delen, en of onafhankelijk, of in een geïntegreerde keten opereren, en zich op de export naar de VS en Canada concentreren. De ontwikkeling van geïntegreerde concepten die innovatie en hoge investering vereisen zijn interessant voor Nederland. Nederlandse betrokkenheid moet door middel van een geïntegreerde aanpak plaatsvinden.

Aanbevelingen. Op basis van gesprekken met verschillende vertegenwoordigers van de Mexicaanse tuinbouwindustrie kunnen een aantal aanbevelingen worden geformuleerd.

1. Her-definieer de term 'hoogtechnologisch'
    a. Associeer dit niet met glasbedekking
    b. Onderscheid de kasconstructie van de kasinstallatie.
2. Werk aan een continue verbetering van 'hoogtechnologisch': het is niet een statisch concept, maar moet profiteren van de laatste technologische ontwikkelingen.
3. Introduceer 'hoogtechnologische' elementen in 'middentechnologische' kassen, met name die elementen die de duurzaamheid verhogen
    a. Hergebruik van drainwater
    b. Geïntegreerde gewasbescherming
    c. Verwarming door middel van zonne-energie.
4. Pas Nederlandse technologie aan aan de lokale omstandigheden
5. Demonstreer de technologie onder lokale omstandigheden
6. Prijs telt in Mexico.
7. Persoonlijke contacten tellen in Mexico.
8. Behoudt focus in de markt.
10. ADAPT, niet ADOPT; "de adaptieve kas"

1 Introduction

The Mexican horticultural sector is strongly developing in a global setting. This makes Mexico a relevant partner for the Dutch supply industry, that, however, has to compete with suppliers from other countries such as US, France and Israel. Future export developments (predominantly vegetables to the USA and Canada - but flowers are coming up) depend on the competitiveness of the Mexican sector in comparison with other Latin American countries and the domestics sector in the United States and Canada, whereas production for the national market (predominantly flowers) depends on the purchasing power and quality requirements of the Mexican consumer.

The Mexican government is actively supporting horticulture to make it an economic sustainable sector bringing benefits to the population in the countryside. Supermarkets (especially the international ones) oblige companies to work in a sustainable, safe and traceable manner. A considerable part of the Mexican companies is struggling with these higher demands, next to the increasing constraints regarding water and energy consumption and other environment concerns.

1.1 Information needs

Available information on the Mexican horticultural sector is out-dated, incomplete, and not always reliable. An accurate and actual description of various market segments (low-medium-high tech, indoor-outdoor, domestic-export, international competitiveness etc.) does not exist. Therefore, an assessment of the Dutch competitiveness on the Mexican market can not be reliably produced, and a strategy to increase Dutch competitiveness is difficult to formulate.

There is a need for a detailed, accurate and actual description of the Mexican horticultural sector, in terms of crops, acreages, production, production system, and market situation. In addition, a product-specific assessment of the Mexican competitiveness on the export market to the USA and Canada, in comparison with other regional suppliers, is required.

1.1.1 Relevance of the information for The Netherlands

Mexican organizations see The Netherlands as a source of know-how and technology for greenhouse production of cut flowers and vegetables. This is confirmed by the fact that in recent years Mexico was the main export destination for greenhouse equipment from Dutch providers. However, a clear strategy for the upcoming years is missing due to the lack of, amongst others, accurate information. This goes for the Dutch exporting companies as for the (local) Mexican government which is promoting the sector actively. The Dutch sector is losing ground in Mexico due to the active market approach by the main international competitors.

From a policy perspective the transition in Mexican horticulture to become a global player gives ample opportunities to cooperate in the field of high tech expertise in innovative production methods, sustainable chain building, social responsible production in relation to land, energy and water use. This is valid for export (mainly vegetables and maybe in the future a part of the flower production) and local consumption (vegetables and flowers).

Horticulture is the priority sector for Office of the Agricultural Counsellor of The Netherlands in Mexico (on annual basis about 70% of the time spent, including trade questions, bilateral negotiations, etc.) The requested research will increase the knowledge on the Mexican horticultural sector which is essential to focus the Office's activities, also because of the cut down in budget for Holland promotion at the main horticultural fair.

1.2 Purpose of the project

The purposes of the project were to provide:

- a detailed, accurate and actual description of the Mexican horticultural sector and its sub-sectors, in terms of crops (vegetables, flowers, bulbs, plants), acreages, production, production system, technological level, innovations, sustainability, market situation, etc.
- an analysis of the technological level that is suitable for specific production and market systems and a view on expected technological developments.
- A SWOT analysis of the Dutch supply industry and export competitiveness, also in comparison to other suppliers to the high and medium-tech Mexican horticultural sector.

1.3 Research method

After a preliminary study of the available information and discussions with the Dutch Agricultural Counsellor in Mexico, and discussions with (aspirant) Dutch suppliers to Mexico, it became clear that accurate quantitative data might be untraceable, specially concerning acreage. As the relevance of this information is relative, it was decided to provide a qualitative description if a quantitative one would not be possible.

By means of a literature review it was defined what institutions would possibly have recently collected data. Interviews have been held with these institutions, that kindly supplied us with information available to them. Data were compared and where necessary extrapolated to supply the quantitative information.

The qualitative information is supplied by the different actors in the sector during interviews, presentations, company visits and telephone conversations and by previously published reports (see literature chapter for detailed information).

This report therefore provides derived and integrated information, based on primary data provided by other institutions.

1.3.1 Main information sources

Table 1. shows the main information sources. See the literature chapter for detailed information about the publications used.

Table 1. Main information sources for this report.

Source (acronym)	Source name	web	English name
AMCI	Asociación Mexicana de Constructores de Invernaderos	www.amci.org.mx	Mexican Association of Greenhouse builders
AMHPAC	Asociación Mexicana de Horticultura Protegida	www.amhpac.org	Mexican Association of Protected Horticulture
ASERCA	Apoyos y servicios a la comercialización agropecuaria	www.aserca.gob.mx	Support and Services for the agricultural commercialisation
FIRA	Fideicomisos instituidos en relación con la agricultura	www.fira.gob.mx	Instituted Trust Funds for Agriculture
FI Habitat Verde	Feria Internacional Habitat Verde Sistema Producto Ornamentales de Morelos	www.feriahabitatverde.com	International Trade Green Habitat Product System of Ornamental Morelos
FOCIR	Fondo de Capitalización e Inversión del Sector Rural	www.focir.gob.mx	Capitalization and Investment Fund for the Rural Sector
INTAGRI	Instituto para la innovación tecnológica en la agricultura	www.intagri.com.mx	Institute for Technological Innovation in Agriculture
SAGARPA	Secretaría de Agricultura, Ganadería, desarrollo Rural, Pesca y Alimentación	www.sagarpa.gob.mx	Secretary of Agriculture, Livestock, Rural Development, Fishery and Food
SE	Secretaría de Economía	www.economia.gob.mx	Secretary of Economy
SIAP	Servicio de Información Agroalimentaria y Pesquera	www.siap.gob.mx	Agricultural and Fishery Information Services

2 General information on Mexico

Mexico has a unique geographical position, bordering the USA, a young population and a rapidly expanding market, which add to the country's potential (World Economic Forum, 2009). It is a large country of 1.96 million km^2, with 32 states united in a federal republic, located in central America, between the United States (to the North) and Guatemala to the South. Figure 1. shows a map of the country with the boundaries and the 32 states.

The population size of 112 336 538 million (2010) increases each year by 1.8%. With an average age of 26 years, it is a young population living mainly in urban areas (77.8%). 57% of the population is economically active, of which 13% in the primary sector *(INEGI, 2010)* . Besides the main language Spanish, more than 100 regional minority languages are spoken, as for instance Náhuatl, Huichol en Purépecha.

Figure 1. Map of Mexico.

2.1 Economy

The average wage is 3.1 US$ per hour (2010), which is slightly lower than that in Chile (3.4 US$ per hour), a third of that in the USA (10.3 US$ per hour) and about ¼ of that in France (+/- 10 €/h) (*INEGI, 2011*). The gross average national income per capita is US$ 9330 per year (World Bank 2011), which is among the highest in Latin America (Venezuela, Chile, Uruguay and Brazil are the countries with higher national income per capita than Mexico). This is just an average, and the income distribution is strongly skewed.

Oil, abroad earnings and tourism are the most important sources of income. The annual economic growth over the last 20 years was 3.3%, a figure that is also anticipated for the coming years. Mexico has the 12th largest global economy, and the largest economy in Latin America. Mexico has free trade agreements with 43 countries. Most agricultural products are traded under NAFTA North American Free Trade Agreement (NAFTA; 85-90% of the trade is with the USA), and EU-Mexico Free Trade Agreement partners. Foreign investments of the last years have been 12 billion per year. In 2007, 1.2 billion were invested by The Netherlands.

In 2010, total imports reached € 301 billion, while exports were € 298 billion (SE 2011) (Table 2.). Mexico's most important import partners are the United States (48%), China (15% - growing), Japan (5%) and South Korea (4%). The Netherlands' trade with Mexico has been growing over the last decade. Mexico imported from The Netherlands €363 million in 2000, which has increased to 2.8 billion in 2010 (0.9% of the total). In the same year, Mexico exported €1.7 million to the Netherlands, its 7th export partner in 2010.

Table 2. Total annual imports and exports by Mexico (in million US dollars). Source Ministry of Economy, Underministry of Foreign Trade 2011

Imports	2000		2010	
United States	127,534.40	73%	145,007.40	48%
China	2,879.60	2%	45,607.60	15%
Japan	6,465.70	4%	15,014.70	5%
Korea	3,854.80	3%	12,776.60	4%
Germany	5,758.40	3%	11,076.80	4%
Canada	4,016.60	2%	8,607.50	3%
Brazil	1,802.90	1%	4,327.50	1%
Netherlands	363.1	0%	2,810.80	1%
TOTAL	174,457.80		301,481.80	

Exports	2000		2010	
United States	146,214.50	88%	238,357.50	80%
Canada	3,569.40	2%	10,700.60	4%
China	310.4	0%	4,197.80	1%
Brazil	690.3	0%	3,784.40	1%
Colombia	500.8	0%	3,760.40	1%
Japan	1,115.00	1%	1,926.30	1%
Netherlands	399.8	0%	1,748.10	1%
Korea	304.8	0%	944.1	0%
TOTAL	166,120.70		298,138.10	

With one of the highest improvements in the regional rankings, moving up eight places, Mexico ranks 58th in the Global Competitiveness Index 2011-212. The competitiveness of the Mexican market in general is boosted by the large size of its internal market (12th out of 142 countries); fairly good transport infrastructure (47th), sound macroeconomic policies (39th), and strong levels of technological adoption (58th). However, the country still suffers from important weaknesses that are holding back its capacity to further enhance competitiveness. Not much progress has been made in addressing the flaws in the public institutional framework (109th). Despite many efforts to fight organized crime, security concerns still exact a high price from the business community (139th). Adopting and implementing policies to boost domestic competition (107th), especially in strategic sectors such as ICT, energy, and retailing, along with additional reforms to render the labour market more efficient (114th) are still needed to increase the efficiency of the Mexican economy (World Economic Forum, 2011).

2.1.1 Agricultural imports and exports

Despite some claims, various data bases (SIAP, SAGARPA, SE) do not show an increase in export of agricultural products. On the contrary, there is a small decline in both export and import of a few per cent. SIAP (January 2010) registered total exports from agriculture and agribusiness (including food and beverages) of 1,179 million US$; against 1,465 million dollars in imports (Table 3.). In ornamentals (cuttings, grafts, flowers, plants) the total export value was 0.63 million US$. Imports of flowers and ornamentals (excluding bulbs) have reduced by 25%, but imports of fresh vegetables have increased by 67%. While total export has declined slightly, exports of non-processed agricultural products and fresh vegetables has increased by 5% and 12%, respectively.

Table 3. Agricultural annual imports and exports by Mexico (in million US dollars).

	Jan 2009	Jan 2010	
Total exports agricultural products, incl. food and beverages	1,211,379	1,178,850	-3%
Total imports agricultural products, incl. food and beverages	1,502,312	1,464,953	-2%
Total exports agricultural products, non-processed	604,860	630,347	4%
Total imports agricultural products, non-processed	605,989	576,799	-5%
Total exports flowers and ornamentals, excl bulbs1	7,034	6,535	-7%
Total imports flowers and ornamentals, excl bulbs	2,085	1,555	-25%
Total exports fresh vegetables	248,683	279,698	12%
Total imports fresh vegetables	16,211	27,006	67%
1 Classification according to The Harmonized Commodity Description and Coding System (HS) HS codes 0602/0603/0604 Source: Banco de Mexico, www.siap.gob.mx			

Destination markets are mainly the USA, accounting for 76% of the agricultural exports. The most important products exported to The Netherlands are orange juice, berries (fresh –raspberries- and processed product), meat, limes and ornamental foliage ("greens").

Agricultural imports account for a similar value, the most important import products being yellow maize and milk. Imports from The European Union are superior to the exports to the EU.

2.2 Climate and energy sources

Mexico is divided by the tropic of Cancer (23 o 26') into a temperate and a tropical climate part. In the temperate part, relatively cool temperatures are registered during the winter months, while in the tropical part, temperatures are fairly constant year round and vary solely by elevation. Tropical areas with elevations above 1000 meters have yearly average temperatures between 24 and 28 °C throughout the year, with only 5 °C difference between summer and winter. Low-lying areas north of the 23rd parallel are hot and humid during the summer and have lower yearly temperatures averages (20 to 24 °C) because of more moderate conditions during the winter. Between 1,000 and 2,000 metres, one encounters yearly average temperatures between 16 and 20 °C. Above 2,000 meters, temperatures can drop to a yearly average of 8 °C and 12 °C. Mexico City, at 2,300 meters altitude, has a yearly medium temperature of 15 °C with pleasant summers and mild winters.

The radiation level is affected by the cloud cover; the eastern coast around the Gulf of Mexico has severe cloud cover (50%-70%) on a yearly basis. Also the western part has some areas with yearly high cloud cover. The lowest cover (< 40%) is in the north.

Rainfall in Mexico creates a pronounced wet (May till mid-October) and dry season. February and July are the driest and wettest months, respectively. Coastal areas, especially those along Gulf of Mexico, experience the largest amount of rain in September (Figure 2.).

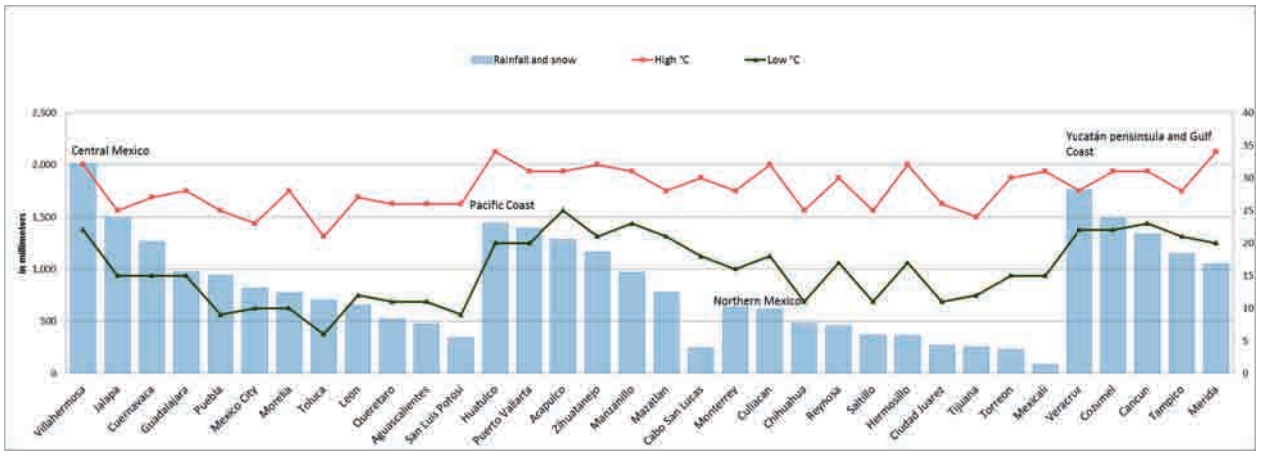


Figure 2. Annual average precipitation and temperature in Mexico (Source Comision Nacional Del Agua and World Meteorological Organization (2011). Data are based on period 1971-2000).

Based on a climatologic study taking light (cloud cover), humidity and temperatures into account and combining climate with thermal, light and humidity crop requirements for some important horticultural crops (cucumber, tomato, pepper, rose and gerbera), Kipp (2010) identified the Mexican central plain and several smaller areas spread through the country as the most stable area for greenhouse production (pink and blue areas in Figure 3.). A large part of the country is too cold for year round production, and is suitable for greenhouse production only if heating is applied (marked area in Figure 3.). Proximity to the nation natural gas pipeline network (shown with a red line in Figure 3.); enables easy access to heating, making an important part of the country suitable for year round crop production.

The use of other energy sources available such as geothermal energy would seriously increase the acreage suitable for production of horticultural crops. Mexico has more than 1300 of the so-called "geothermal manifestations" (orange dots in Figure 4.); it occupies the 3rd place in the world in the production of electricity from geothermal energy (triangles in Figure 4.), for which very high water temperatures (> 180 °C) are needed. However, for the warming of the greenhouse, water temperatures of 60-90 °C are sufficient.

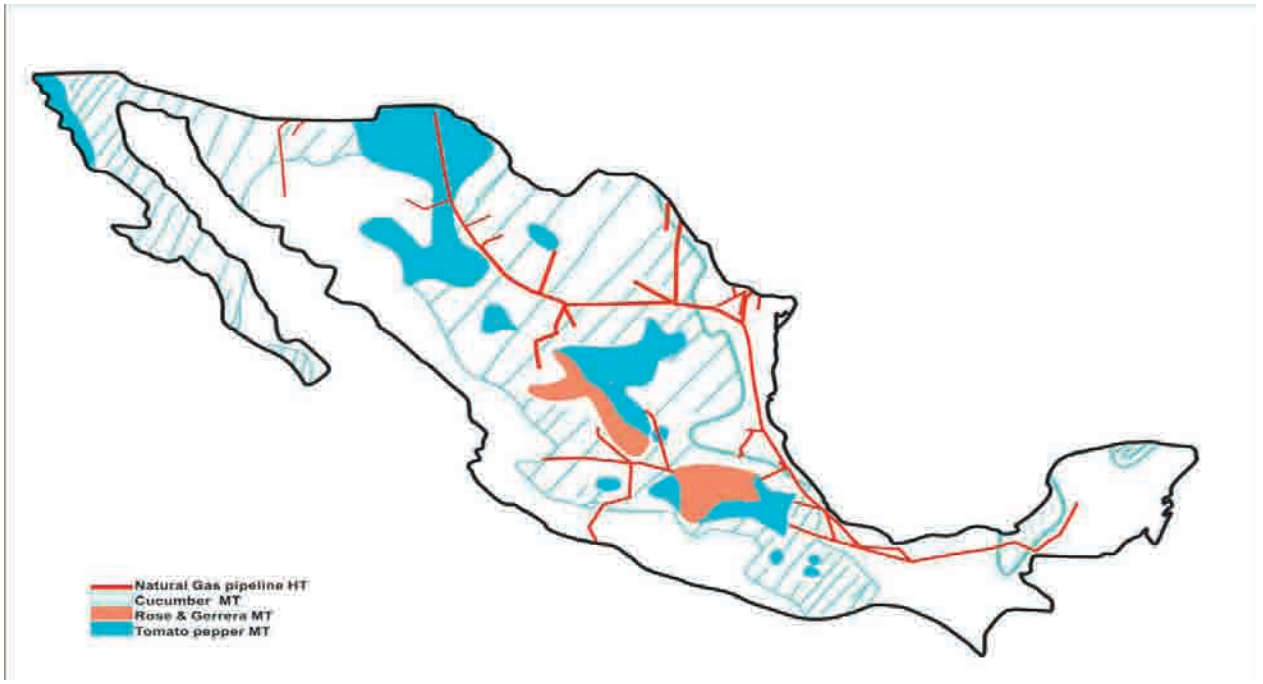


Figure 3. Optimal climatic regions for production of main vegetable crops and Natural Gas national pipeline network (Kipp, 2010).

Figure 4. Geothermal resources in Mexico, (Mercado et al., 2008).

2.3 Agriculture

The Mexican national territory covers 198 million ha, of which 15% is dedicated to agriculture; 58% to grasslands, and of which 23% consists of (tropical) forests and woods. The remaining 4% is covered by water bodies and human settlements. Agricultural activity is realized on approximately 145 million hectares in diverse ecosystems in the country. (SAGARPA, 2007)

Agriculture is important to the country because 20% of the population is employed in agriculture, which contributes only 4% to the gross national product. (*INEGI, 2010*). However, most of the agricultural area of the country is in hands of small producers as and the majority (72%) of the production units is smaller than 5 ha; this is greatly explainable by the land possession system, see 2.3.1.

Agricultural production reached in 2010 a harvested area of 18.7 million ha. Of this surface, 13.4 million ha were dedicated to fruits; and 545 thousand hectares to vegetables; representing a value of respectively 65,000 million pesos and 52,000 million pesos (SAGARPA, 2011).

Water shortage is an important issue, and only 23% of the agricultural land is irrigated.

Mexico is a net-importer of food, in particular grains, soy, meat and dairy. The most important agro-export products are beverages and vegetables.

2.3.1 Land possession in Mexico and its relevance for agriculture

Mexico's territorial land and water, although being in the first place ownership of the nation, are divided in 3 types of property: public / federal (8%), private (40%, including small agricultural property) and social (52%, "ejidos" and "comunidades").

Article 27 of the Mexican Constitution (from 1917) regulates the land possession and the use of water in Mexico. The Mexican state reserves the right to take back any land property by expropriation, always after paying compensation whenever the expropriation is needed for public utility. Although the possession of land in the constitution is limited to Mexicans, foreigners can also obtain the right to rent and own land and real state under certain conditions. This right is restricted to areas separated 100 km from the borders or 50 km from the coastal line. The foreigner does not obtain the property rights (they belong to the bank) of the land but is the "beneficiary" and can use, enjoy, sell and inherit the property, but always needs the approval of the bank for every operation, and needs to respect the size limitations imposed to agricultural use (small agricultural property, see below).

Property registration is not compulsory. Registration of the different forms of properties occurs by different government bodies. From 1992 a new attempt to regulate the land possession was launched, but registration is still deficient.

2.3.1.1 Social property

Communal property land belongs to the total of the members of a community and the benefits of the land are supposed to be divided among all the members of the community. Ejidos are a form of social property in which a group of individuals use a piece of land for agricultural or cattle purposes. Each member of the Ejido can own up to a maximum of 5% of the total extension.

Though the Ejido system claims to have its origin in pre-Colombian communal land tenure regime, and Spanish tradition of public lands, it was created after the Mexican Revolution. The Mexican Revolution was in large part a peasant rebellion against a highly unequal distribution of land ownership and wealth. The demands of Emiliano Zapata's rebel forces were expressed in their famous battle cry Tierra y libertad (Land and liberty). The Ejido system was introduced as an important component of the land reform program after Lázaro Cárdenas became president in 1934.

By the early 1990s, the Ejido sector accounted for approximately half of Mexico's farmland —and half its irrigated land—, and three quarters of the nation's producers and provided a critical instrument for the Government to implement its production and marketing policies for the agricultural sector.

In 1991, by many seen as a preparation to the North American Free Trade Agreement (NAFTA), President Carlos Salinas de Gortari eliminated the constitutional right to Ejidos by amending Article 27 of the Mexican Constitution, citing the "low productivity" of communally owned land. Ejidatarios were now allowed to sell or lease their parcels (which was, although illegal, common practice) or to join into partnerships with private enterprises. The 1992 legislation ended the creation of new Ejidos—bringing to an end Latin America's longest running land reform - and offered existing Ejido members the opportunity to obtain private titles to their Ejidal land (Smith and Gruben, 1992).

Similarly, as part of the overall reform package, the Government also no longer provided widespread technical assistance, input and output subsidies, and government marketing channels. As a result, by 1993, while the Ejido sector had more freedom to allocate its resources, it was in an institutional vacuum without much governmental support to facilitate the adjustment to a market economy with rapidly changing incentives (Cord & Wodon, 2001; Johnson, 2001). While farmers' associations in the '60s and '70s had dedicated much efforts to demanding land rights and infrastructure / services from federal and state government; in the '90s they changed their focus towards more economic activities directed at the development of markets for the production of their members. Nevertheless, the political lobbying force of farmers' associations is still strong, as they have historically rooted links to Mexican political parties (patronage systems) (Valk, O. van der, 2007).

The Ejido system makes the agricultural sector very fragmented and dispersed in an enormous multiplicity of small plots of 1000 m^2. This is an important reason for the small acreages of greenhouse farms in Mexico. Ejidos and Communal land configure the "social sector", who is also the main beneficiary of the newest policies to potentiate protected horticulture.

2.3.1.2 Private property

As mentioned above, only about 40% of the Mexican territory is in private hands. The northern states (Chihuahua, Sonora, Coahuila, Tamaulipas, and Nuevo León) have the biggest area of private property. The states of Federal District, Morelos, Tlaxcala, Colima and Aguascalientes have the smallest area. The state of Nuevo León has the highest fraction privately owned land (2/3 of the total), followed by the states of Tamaulipas, Sonora, Chihuahua and Coahuila. The States with the lowest percentage of privately owned agricultural land are Guerrero, Morelos, Baja California and Oaxaca. The percentage of land privately owned in a state is in general inversely related to the socially owned land, with the exception of Guanajuato, Puebla and Aguascalientes where it is balanced (Ibarra and Morales, 1998).

Agricultural property is limited to small plots. Small properties are maximized in size to no more than 100 ha of irrigated land per individual, or its equivalent in other forms of agricultural land; equivalent to 1 ha of irrigation, for instance, are 8 ha of forest of arid land. (The cultivation of certain crops can give and help to increase the minimum size of the "small property"). Land improvements that lead to an increase in production (the conversion to irrigated land by the owner or the use of protective structures) do not always lead to expropriation of the excess land, and that explains why some properties have become big despite the applied size restrictions.

2.3.2 Protected horticulture

Protected horticulture is defined as agricultural activities taking place under cover. It is a fast growing activity in Mexico, with a large potential to increase yield, quality and market competitiveness. The sector has two major components, viz. the cut flower and ornamental sector that produces mainly for the domestic market, and the vegetable sector that produces both for the domestic market and the export to the USA and Canada.

Details of protected horticulture are presented in Chapter 3. Here we just summarize the advantages and disadvantages of the sector in comparison to open field cultivation (according to SAGARPA, 2011):

- Increase in yield
- Increase of quality (more % of high quality produce)
- Decrease of the seasonality
- Less use of water, fertilizers and agrochemicals
- Improved control of pests and diseases
- Possibilities for more than one cultivation cycle per year and even for year round cultivation

Next to these mentioned commercial and environmental advantages, protected cultivation has also an important social impact (SAGARPA, 2011):

- Generates 8 permanent jobs per hectare
- Contributes to regional development
- Suitable for small soil surfaces
- Contributes to a higher life standard

Mexican sources mention as disadvantages:

- High initial investments
- High operational costs
- Practical knowledge and experience in protected cultivation is required.

•

3 The Mexican Protected Horticultural Sector

Protected cultivation started in Mexico between 1990 and 1995 in the 20th century. Due to the advantages of protected agriculture, it grew from approximately 750 ha in 1999 to approximately 12,000 ha in 2007, when more than 18,000 production units were registered, of which 2409 production units were older than ten years and more than 8,000 units were younger than 2 years (INEGI 2007). About 50% of the commercial structures were shadow houses, 48% are covered with plastic and a maximum of 1% has a glass cover (see paragraph 3.1 for the types of greenhouses).

Table 4. Seasonality of greenhouse and fresh field tomato shipped to North America by region (Cook and Calvin, 2005).

		J	F	M	A	M	J	J	A	S	O	N	D
Field grown	California												
	Florida												
	Rest of USA												
	Sinaloa, Mex.												
	Baja California, Mex.												
	Canada												
Greenhouse	Canada												
	USA												
	Sinaloa, Mex.												
	Imuris, Sonora, Mex.												
	Central Mexico												
	Baja California, Mex.												

Official sources (SAGARPA, 2011) indicate a surface under protected cultivation of 11,759 ha in 2010, while estimates by professional organizations mention surfaces with protected cultivation close to 30,000 ha. Regardless of the exact number of hectares where protected cultivation is being practised in Mexico (see paragraph 3.1), protected horticulture in the country has led to several important improvements making the supply of products independent of the traditional supply periods (Table 4.). Also the product quality and yield per hectare have significantly improved (Figure 5.) giving the Mexican produce a better position not only locally but also in its North American markets: In 2010, the horticultural produce volume reached the 3.5 million tons (data SIAP, SAGARPA 2011), of which approximately 60% is exported.

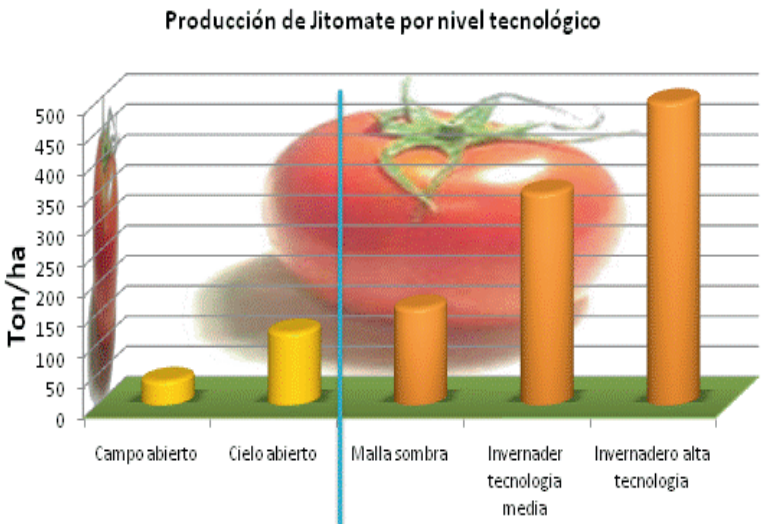


Figure 5. Production of tomato in open field (yellow bars) and in protected cultivation, as influenced by the technological level of the cultivation system (source FIRA-Agronegocios (03/10/08).

For this reason protected horticulture is considered a strategic sector by the Mexican government, which is extensively promoting and financially supporting with subsidies the construction of greenhouses for vegetable production at all levels, with special emphasis on the so called "social sector" (see paragraph 2.3.1.1). This emphasis is visible in the average size of the protected horticulture exploitations, as 30% of them is smaller than 500 m^2 and 86% is smaller than 5,000 m^2. According to FOCIR data, only about 25% of the production originates from the social sector; the other 75% of the production is obtained in the private sector.

As a result of the governmental promoting efforts and the growing dynamics and competitiveness, the area dedicated to protected horticulture has grown explosively, at a rate that could reach 1200 ha per year (depending on the data sources), predominantly in the lowest technological segment.

3.1 Greenhouse types

Protected horticulture is defined as agricultural activities taking place under cover. In Mexico, three main types of cover structures are found:

1) Shadow houses: a cover reducing light intensity and partly stopping insects (Figure 6.). A variant to this are the shadow roofs, just the roofs without walls.
2) Plastic tunnels: micro and macro tunnels with a plastic cover that stops heavy rains and sharp sunlight (Figure 7.).
3) Greenhouses with plastic (Figure 8.) and glass covers (Figure 9.). These account for less than 1% of the total area covered for horticultural production.

In Mexico (SIAP, 2010) there are 8682 greenhouses, 2243 shadow houses and shadow roofs, 2929 tunnels (micro + macro) and 416 "pavilions". This fourth type of structure exists almost exclusively in the State of Chiapas, called "Pabellón" (pavilion or shelter tent in English) consisting of a transportable metal structure with an insect net cover. The grower can place it above a different crop every time, since the structure is not fixed (Figure 10).

Shadow roofs are greatly found in Chihuahua. Macro and Micro tunnels are found in many different areas, and have a significant presence in the state of Mexico.

Figure 6. Shadow house in the state of Morelos, left outside, right, inside.

Figure 7. Macrotunnel. Source AMCI.

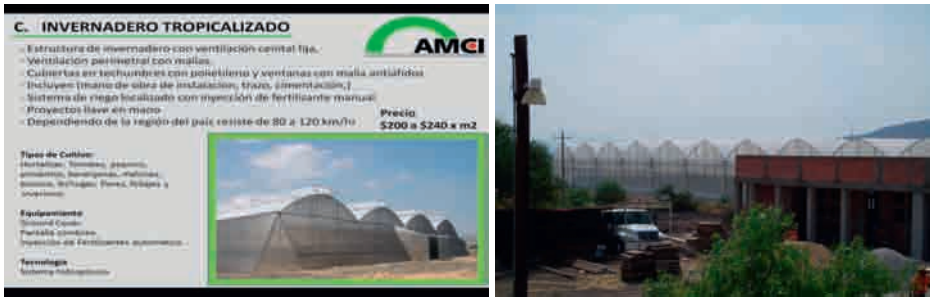


Figure 8. Greenhouses with plastic cover and net walls (left) or plastic walls (right) in the state of Querétaro.

Figure 9. Greenhouses with glass cover in the state of Querétaro.

Figure 10. Pavilion in the State of Chiapas (source SIAP).

3.2 Data quality

3.2.1 Discrepancies among data sources

The fast growth of protected cultivation and the lack of a national registration system result in great difficulties to obtain reliable quantitative data. A considerable contribution to this data confusion is the low success rate, as especially among the "social sector" many greenhouses (in certain states this can represent well above 30% of the registered enterprise surface) are abandoned within a period of 2 years after their construction. Efforts are made by several organizations (SIAP, SAGARPA, INEGI, AMPHAC, AMCI, FIRA) to quantify the horticultural sector. Their figures originate from members or beneficiaries to their programs. Data are contradictory (Table 3.), but give an idea of the magnitude: SAGARPA, the office of the Agricultural Counsellor of the Ministry of Agriculture works with nearly 12,000 ha in 2010. Other sources mention acreages varying somewhere between 9,000 and 30,000 ha.

The main differences between the sources are:

- The definition of "protected horticulture": certain sources (SIAP, AMCI) consider macro and micro tunnels and shadow houses as protected horticulture, and even structures without cover (but operational inside a greenhouse-like structure). Others (AMHPAC) consider shadow houses but not plastic tunnels.
- The data collection method: by means of general surveys per municipality (SIAP) or by means of surveys among members (AMPHAC, AMCI). SIAP data are estimated of the total surface operational in the year previous to the survey. AMPHAC data estimate about 50% of the total acreage, 20% of the total number of enterprises, but 70% of the exports.
- The extent to which abandoned greenhouses are considered active (AMCI does not record abandoned greenhouses, SIAP's survey asks for greenhouses that were used in the previous year (in this case 2009), and AMPHAC validates by means of telephone calls that the greenhouses are operational.
- The focus of the data: SIAP data are collected and processed per "observation unit". One observation unit is one enterprise, which can consist of one or more greenhouses / shadow houses. AMPHAC data are processed per "validated contact", one validated contact is one company whose existence has been verified by means of a telephone call. AMCI data are processed per constructed hectare by AMCI members.
- The extent to which small size exploitations have been included in the collected data (Office of the Agricultural Counsellor of The Netherlands in Mexico did a survey in which the technology level (see Table 3.) and the size were combined as selection criteria: so all the High Tech producers, Medium Tech producers with more than 10 Ha, and the 10 largest Low Tech producers).
- Financial organisations (FOCIR, FIRA) have data on operations with subsidies or with credit.

3.2.2 Abandoned greenhouses

The reliability of the quantitative data is affected by the fact that many greenhouses are abandoned (Figure 10). Data by AMPHAC 2009 indicate that this can reach a very high fraction of the total registered protected horticulture companies, varying from 31% in the State of Baja California Sur till more than 80% (!) in Sinaloa. However, this latter number seems not realistic. More recent data from SIAP-SAGARPA (Table 5.) indicate that the highest fraction of not-operational production units in Baja California Sur (26%), and the lowest in Mexico and Michoacán (1%). According to these data, all greenhouses in Sonora are operational. Abandonment appears mostly related to vegetable cultivation. The states of Mexico and Morelos have relatively much ornamental cultivation (paragraph 3.4.2 and show hardly any abandonment.

Table 5. Percentage not-operational greenhouses in 15 estates (source SIAP-SAGARPA 2011).

State	Nr of enterprises	% not-operational
Baja California	243	7%
Baja California S.	86	26%
Chihuahua	147	3%
Coahuila	73	19%
Durango	170	10%
Guanajuato	485	18%
Jalisco	526	5%
Mexico	1421	1%
Michoacán	583	1%
Nuevo León	220	21%
Puebla	1219	15%
S. Luis Potosí	401	17%
Sonora	101	0%
Sinaloa	154	2%
Zacatecas	298	7%

There are several reasons for growers to interrupt greenhouse production and abandon the greenhouse. The interviewed experts and some discussion fora on the internet (www.hortalizas.com) give a number of reasons for the lack of success that leads to the abandon of greenhouses. There are four main reasons: lack of knowledge, from the planning to the investment and the production to operate under the new growing environment (K, knowledge), lack of a market able to absorb the extra production and to pay for the improvement in quality (M, market), insufficient size to make the operation profitable (S, scale), and the access to subsidies and credits (C, credit). More specific reasons that are mentioned by growers, consultants, researchers, and market specialists, can be placed in these four groups:

Figure 11. Abandoned greenhouses in the surroundings of Mexico-City.

Lack of knowledge

- The greenhouse supply industry sells standard greenhouses, not adapted to the local conditions, and does not advice on the cultivation methods with the offered technology.
- Lack of planning has led to the construction of greenhouses in places where water availability is limited.
- The growers do not invest (or do not invest enough time and money) in training and knowledge development. They are also not used to pay for technical support by experts in nutrition, pest and disease control, planning and marketing.
- The quality of the planting material is not always guaranteed: varieties offered are not always sufficiently adapted to the local conditions and, there are different seed qualities offered on the market at different prices: the growers do not always buy the best but rather the cheapest seed, that can lead to disappointment.
- Certain growers buy a greenhouse and start cultivating without a previous feasibility study where investment, production costs, planning, risks and market have been analysed. There is serious lack of advisors to help growers with these feasibility studies.
- Starting growers underestimate the investment cost and the initial production costs.
- Almost everybody grows the same product (tomato) because of the lack of market information.
- Lack of production planning.
- The export market's quality requirements are a lot higher than for local market and many growers can no comply with them (besides acreage (S)).

Lack of market

- The local markets are not able to distinguish a product from the open field from one grown under protection, and for sure not prepared to pay more for it.
- Lack of production planning capacity (K) leads to price fluctuations.
- Wholesale markets and distributors pay very low prices; if growers succeed in direct sales they are more successful.

Insufficient scale

- A great number of the greenhouses are too small to be financially interesting.
- The export market requires much higher surfaces (depending on the sources, 5 or 6 ha are mentioned as minimum required size for export (besides quality requirements (K)).
- Fragmentation leads to higher transaction and coordination costs to reach sufficient scale among small scale farmers (besides lack of market (M)).

Access to credit

- Few mention the existence of a lot of governmental support (subsidies and low interest credits) as one of the causes of failure. According to them, when growers build a greenhouse with their own economic resources, they have an increased chance of success. “Free” or “almost free” greenhouses were offered to growers without conditions like previous knowledge, a feasibility study, having followed trainings, a market study. The conditions for new credits and subsidies have been sharpened with this kind of exigencies, particularly regarding knowledge, clustering and the focus on integration into the market chain (see paragraph 3.7).
- Certain growers and advisors feel that Mexico is too dependent on foreign technology and production means as fertilizers, seeds and varieties, which not in the last place due to transport costs and profit margins for agents and distributors lead to too high production costs. Foreign advisory services that accompany imported technology are disproportionally expensive in comparison with local wages.
- If growers have succeeded in direct sales then the needs for credit increase as they need to have own vehicles, own packing system, etc.

According to technicians from the FIRA development centre in Tezoyuca (Morelos), the first year after construction of a small greenhouse is the most critical for the company continuation. If the first year is successful, the first step is usually to increase the size of the exploitation, and only after that moment the growers are ready for the next technological step. This development model is shown in Figure 12.

First year success

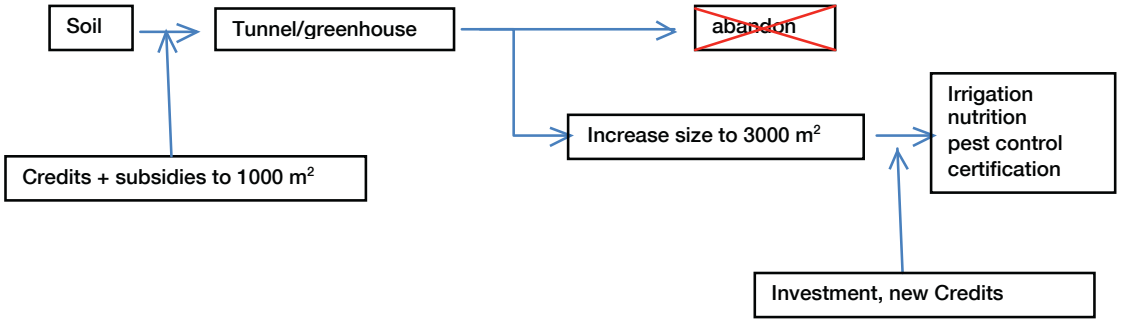


Figure 12. Development dynamics (from soil production to medium technology) in the area of Morelos (source technicians form the FIRA development centre).

3.3 Regions with protected cultivation and acreages

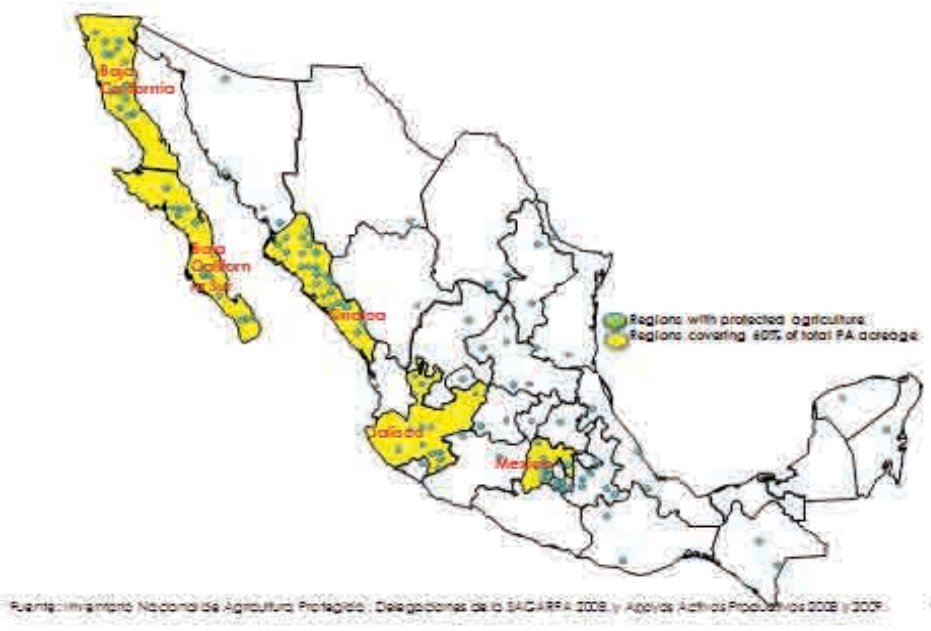


Figure 13. Chart of Mexico indicating the areas with protected cultivation. Source Inventario Nacional de Agricultura Protegida, SAGARPA, delegaciones de la SAGARPA 2008 y Apoyos Activos Productivos 2008 and 2009.

Protected horticulture is found in about 31 of the 52 states, with clear concentration in terms of acreage (60%, according to SAGARPA data) in 5 states, marked in yellow in Figure 13: Sinaloa (accounts on its own for about 30%), Baja California, Baja California Sur, Jalisco and Mexico. San Luis Potosí, Morelos and Puebla are also important in terms of the acreage. The most recent agricultural survey was conducted by the Sistema de Información de Agricultura Protegida (SIAP) in 2010[1]. According to this study, the predominant protective structure in the important regions of Sonora and Baja California Sur is the shadow house. Greenhouses are the predominant structure in Sinaloa, Baja California and Jalisco. Surveys by the Office of the Agricultural Counsellor of The Netherlands in Mexico confirm that the largest acreages are in the states of Baja California and Sinaloa, but these are areas with the lowest technology level (see Table 6.).

Other states have relatively low acreages of protected horticulture or low number of greenhouses, but are characterized by higher technology levels. This is the case for Chihuahua, Coahuila, Guanajuato, Jalisco, México, Michoacán, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Sonora and Zacatecas. For this reason, such regions are of interest to Dutch industry.

3.3.1 Regions with increasing acreage

According to AMPHAC, strongest growth takes place in Sinaloa, followed by Jalisco, Guanajuato and Michoacán. Acreage in Sonora, where 40% of the enterprises enjoy subsidies, is decreasing. The growth depends on the production level and the commercial links. Jalisco's growth can be attributed to a good working model, with communal packing lines, production consolidation, and clustering of the social sector enterprises. The Chiapas model has been less successful because of the unsuitable technology used (shadow houses in a rainy area) and the fragmentation of the investments. A publication by CIDH CAADES, 2011 by the end of the 2010-2011 campaign, mentions a record acreage dedicated to protected horticulture in Sinaloa: 4249 ha, of which 715 hectares of greenhouses and 3500 ha of shadow houses. The increase compared to 2010 was 25%.

1 At the moment of writing this report the data have been processed for about 85% of the total. Missing information concerns the states of Querétaro (treated separately) and Veracruz.

Table 6. Acreage of greenhouse production per state according to different sources.

State	AO of NL Embassy: technology level			AMHPAC 20081	FIRCO 2008	SAGARPA dept. 1	SIAP 20113	SAGARPA 2010		$AMCI_4$ (2009)
	L	M	H				ha	ha1	% total	% growth
Aguascalientes				161	54	16	60			0.4
Baja California	1317			2300	959	1314	2642	1635	13.9	11.9
Baja California Sur				170	1416	1278	1142	1388	11.8	0.1
Campeche						4	43			1.3
Chiapas				65	36	23	221			1.0
Chihuahua			54	375	126	26	1070			0.0
Coahuila		34	22	380	287	30	127			1.0
Colima				50	116	418	243			1.2
Distrito Federal				12		32	125			0.4
Durango		199		45	59	7	838			0.9
Guanajuato		75	11	100	78	75	534			3.4
Guerrero					4		437			0.1
Hidalgo				120	54	108	119			0.9
Jalisco		75	555	970	619	619	1815	1152	9.8	18.9
Mexico			82	160	978	978	559	1035	8.8	-
Michoacán		5	39	85	148	22	637			30.3
Morelos				45	26	498	111	541	4.6	0.9
Nayarit				40	110	40	65			3.0
Nuevo León				20	48	40	91			2.4
Oaxaca				70	26	47	255			2.3
Puebla		11		140	35	239	299	482	4.1	2.7
Queretaro		3	73	155	74	87	162			2.1
Quintana Roo		60	40	65	53	55	64			0.3
San Luis Potosí		60	50	240	179	499	780	611		0.5
Sinaloa	475	1810	36	2980	2526	2526	2490	2572	21.9	7.5
Sonora		57	35	890	951	79	1048			2.6
Tabasco					2	2	9			0.0
Tamaulipas				35	76	180	202			0.6
Tlaxcala				45		39	45			0.6
Veracruz				110	14	85				0.8
Yucatán				10	28	24	30			0.6
Zacatecas		20	10	150	216	156	305			0.8
			4653	9948	9298	9502	16373	11759		
1 Source: SAGARPA 2009 (ppt Proyecto de Ejecución Nacional) 2 Area per state calculated with given percentages of total. Source: SAGARPA 2011 3 Source: Sistema Nacional de Información de Agricultura Protegida, 2010. SIAP-SAGARPA. 4 Source: Encuesta nacional de invernaderos 2009, AMCI										

A 2009 survey by AMCI presents the relative growth in acreage of greenhouse constructions. Important growth in 2009 and 2010 has taken place in the States of Michoacán (607 ha constructed in 2009) and Jalisco (376 ha constructed in 2009), see Table 3. According to AMCI, the growth has been of approximately 2520 ha constructed in 2009, of which 520 ha by AMCI members, and a projected estimate of 3250 ha in 2010, of which 787 by AMCI members (mainly low technology level, see 3.3).

3.3.2 Querétaro

The state of Querétaro deserves special mention since it hosts the first "Agropark", a 800 ha area of high technology greenhouses of which about 100 ha is used for the production of mainly tomato and sweet pepper. The park offers all necessary infrastructure such as water from underground sources, electrical power, natural gas, telephone and internal urbanization, like roads, security, etc. The companies pay for the common services but operate independently though in all aspects of production process and commercialization. The local government offered the land, and FOCIR (see 3.9.2) offered finance obtaining 25% of the shares. Also in Querétaro a new but important knowledge centre to serve, amongst other horticulture, has been created (see 3.8.2.). One of the first companies to settle in Querétaro was Netherlands owned and managed. The reason to choose Queretaro was the availability of water, of gas, and good contacts with authorities.

According to SIAP data, the state of Querétaro in 2006 had only 82 ha of greenhouses, in 2007 119 ha and in 2009 a total of 162 ha operational. In 2009, the total area destined to greenhouse cultivation was 0,07% of the total State agricultural surface, but it was responsible for 13,6% of the production value.

In 2009, the municipality of Colón, where the Agropark in Ajuchitlán is located, accounted for 43 ha operational greenhouses. This surface has almost doubled in 2011. The Agropark therefore represents more than half of the total protected cultivation area of the state of Querétaro. A further 45 ha or more Agropark is projected to be constructed in 2011 and 2012 (pers. comm.). In terms of value, Colón and its southern boundary municipality, Pedro Escobedo, in 2010 accounted for more than 2/3 of the state's greenhouse production value.

The states of Aguascalientes and Morelos are also considering the creation of new Agroparks.

3.3.3 Morelos

Morelos is another state deserving a special mention, as it is one of two states (the other one is the state of Mexico) with a significant production of ornamental plants. Morelos is the 2nd smallest state in the Mexican Republic and the cradle of the "sistema Ejidatario". This makes the agricultural sector very fragmented and dispersed in lots of small plots of 1000 m^2, called one "tarea"(=task). Morelos targets in 2012 900-1000 ha of protected vegetable cultivation. Now there are about 700 ha. According to technicians from the FIRA research centre, growth (300 ha) is expected for medium technology level. Because the registration of acreage, production and sales is deficient, there is no way to quantify the ornamental income, but technicians from the research centre Tezoyuca are sure that ornamentals are the number one agricultural product, higher than tomato (4th regional agricultural product).

3.4 Crops

3.4.1 Vegetables

The greatest part of the protected cultivation acreage is dedicated to greenhouse vegetables. The main products grown are tomatoes in all their types (roma, cherry, truss). Tomato is the most important crop and accounts for 70% of the total Mexican protected cultivation area (SAGARPA 2010). Data by AMPHAC show that in the four Mexican states with the highest acreage of protected horticulture (Table 7.), almost half of the total acreage is dedicated to Tomato. Also cultivated are bell peppers in all colours (16% of the national and 25% of the Sinaloa acreage), cucumbers (10% of the national and more than 50% of the Baja California protected surface), eggplant and green peppers ("chile"). The seed for tomato is mostly foreign, with the Dutch seed companies well established in this market. There are propagators that sell small plants all over the country.

Table 7. Production acreages of vegetables of four states. Source AMPHAC 2009.

	Tomato		Cucumber		Chili pepper		Egg plant		Pepper	
	ha	% of total area	ha	% of total area	ha	% of total area	ha	% of total area	ha	% of total area
Sonora	524	43.3	503	41.9	168	14	5.4	0.5		
Sinaloa	1341	41			1079	33	33	1	818	25
Baja California	408	28	805	54.9	221	15.1			34	2.3
Baja California Sur	125	46.3			136	50.5			8.6	3.2

A horticultural produce gaining importance in both acreage and returns (greatly export oriented) is berries (raspberry, strawberry, blackberry). The surface constructed in 2008 by AMCI members for this crop was 300 ha, in 2009 it was slightly lower with 234 ha, and the estimates for 2010 were 432 ha (compared to around 70 ha destined for the production of tomato in 2008 and 2009 and the for 2010 estimated 193 ha). Berries are an interesting marketing product but hardly relevant for the Dutch supply industry as they are mainly grown in macro tunnels with drip irrigation. At the moment, berries together with chilli peppers, eggplant and other vegetables represent about 4% of the total.

3.4.2 Ornamentals

Helped by government support, floriculture expanded rapidly in the 1980s and 1990s. About 14,000 ha of agricultural land are devoted to ornamental flowers, with 10,000 growers concentrating on 50 different varieties, the most important of which are gladioli, roses, chrysanthemums, carnations, birds-of-paradise and the nard.

Production of cut flowers in Mexico is highly concentrated with 82% of the national production located in only five states. The main production areas of cut flowers are the State of Mexico, Puebla, Morelos, Michoacán, Guerrero and Baja California. The states of Mexico (Tenancingo area) and Morelos are considered to have significant acreages of protected cut flower and potted plant production. In 2006, 48% of the total national acreage destined to flower production was in the state of Mexico. Morelos has more importance for potted plants, bedding plants, shrubs and also young plant production. The central states are characterized by their moderate climate and proximity to the capital Mexico City, which is the centre of flower trading and consumption. However, the national overview by SIAP (Table 8.) shows that flowers (roses, chrysanthemums and aster) are produced in many other states. In the State of Nuevo Leon, for instance, all active production units from the survey cultivate roses. In the state of Chihuahua, 100% of the production units is dedicated to the cultivation of cut flowers. Also in the states of San Luis Potosí and Zacatecas more enterprises seem to be dedicated to the production of cut flowers than to that of tomato. This seems to apply even to the state of Sinaloa and Baja California Sur. Presumably, the companies dedicated to flower production have a much smaller size than the ones dedicated to vegetable production.

In 2007 it was estimated that about 75% of all flower growers in the State of Mexico had less than 0.5 ha; 15% of the farms had a surface (covered and open air) between 0.5 and 10 ha and only 9% of all farms had a flower growing surface larger than 10 ha (de Rijk 2008). At the national level only an estimated 8% of total flower production was grown under greenhouse conditions, the rest (92%) in the open field. Most technology used were steel constructions with plastic covering, and heaters against frost. Irrigation and fertigation is done by hand.

Baja California has its specific climate and a large market on the other side of the border. Around 80% of the production in Baja California is exported to the United States. Only part of this production is grown in greenhouses (estimated at 70ha. in 2006), the main part, particularly carnations, are cultivated in open air (de Rijk, 2008; Geo-Mexico, 2011).

Table 8. Products cultivated in 15 states (source SIAP- SAGARPA 2011).*

State	Number of entreprises	Products cultivated (% of enterprises cultivating the products mentioned)					
		tomato	cucumber	chili	rose	chrysanthemum	aster
Sonora	101	52%	1%	0%	39%	1%	7%
Sinaloa	154	25%	0%	0%	39%	0%	36%
Baja California	243	89%	0%	0%	4%	3%	4%
Baja California S.	86	26%	0%	0%	51%	2%	21%
Chihuahua	147	0%	0%	0%	33%	0%	67%
Coahuila	73	17%	0%	0%	17%	0%	67%
Durango	170	0%	12%	0%	0%	4%	84%
Guanajuato	485	21%	5%	2%	53%	11%	7%
Jalisco	526	13%	14%	2%	62%	2%	8%
Mexico	1421	1%	38%	61%	0%	0%	0%
Michoacán	583	63%	16%	0%	16%	5%	0%
Nuevo León	220	0%	0%	0%	100%	0%	0%
Puebla	1219	45%	20%	0%	16%	9%	9%
S. Luis Potosí	401	11%	0%	2%	14%	16%	57%
Zacatecas	298	21%	1%	1%	1%	13%	47%

* The state of Mexico, even though it is the a producer of flowers, does not produce rose, chrysanthemum and aster according this table. Also, information on the state of Morelos is lacking in this table.

In 2004 the region Villa Guerrero represented around 3.000 hectares of the total production of this state (not all under protection); representing 72% of the production in the State of Mexico and 24% of the national production of cut flowers. Other important production regions, also located in the State of Mexico, are Tenancingo and Coatepec Harinas. Chrysanthemum is the main flower variety grown in these regions. Gladiolus is the most important flower grown in Mexico in terms of area; and roses in terms of value (de Rijk 2008).

The potting plant industry is, in contrast to the cut flower industry, widespread throughout the country. Based on the statistics presented by SIAP, San Luis Potosí (41%) and Puebla (28%) showed the highest potting plant production in 2006. However, Morelos and Jalisco are also considered important potting plant suppliers in Mexico. Besides these states there are several other states, like the State of Mexico, Chiapas, Colima and Distrito Federal who are increasing their potting plant production (de Rijk, 2008).

The ornamental sector is traditionally an older sector than that of the vegetables, with more than 50 years of experience, and according to certain experts, more professionalized, better organized, and more successful. A good extensive report for the ornamental sector in open fields and in greenhouses has been elaborated by the Office of the Agricultural Counsellor of The Netherlands in Mexico (De Rijk, *et al.* 2008).

The plant material for ornamental production is foreign (95% imported); a large part of it is coming from The Netherlands. The Mexican growers feel they are greatly dependent from the USA and The Netherlands. Well represented Dutch companies are Anthura and Terra Nigra.

3.5 Level of technology

An arbitrary classification of the technology level of the protecting structure and the internal components is used in Mexico: “Low-Tech”, “Mid-Tech” and “High-Tech”. However, not everybody is happy with this classification, because definitions of the three categories vary, and different users apply different interpretations.

Classifications suggest that “high-tech” is the highest possible technology and can not be improved upon. However, horticultural developments are very dynamic, and there is always room for improvement. AMPHAC prefers to refer to “active”, “semi-active” and “passive” climate control to avoid the normative suggestion that higher-level technology is always the best, while this depends on the necessity to externally control natural climate conditions. They rather speak of best-fit technology.

A fundamental problem of classifying is the simplification (of even denial) of transition processes. A construction of greenhouses, with an installation inside, and with a particular cultivation system of course never jumps from one level to the next one. Such is a gradual, stepwise process in which elements are replaced by more advanced ones. For example, a pumping system is replaced by a new one with a higher capacity, followed later by a computer system that enables the grower to make better use of the new possibilities the better pump offers. If that is done, it might be economically sound to invest in an upgrade of the ventilation system. And the grower will surely discover that training is required to make best use of the new device and maximize yields. A good transition process keeps the various elements well-balanced. For a fair judgement, it is required to present a reasonably detailed description of a greenhouse farm.

It is only the big investors that can start a greenhouse system at the high-end level at once, which is an entirely different approach. Investors from other sectors (textile, house construction, steel) are coming to the horticulture according to different sources; they are successful because they find the right people to work for them.

Keeping this in mind, we nevertheless present the definitions that are used by various parties, as the terminology is widely used and as it in some instances eases the discussion.

3.5.1 Classification criteria

We encountered during our interviews that “High Tech” is often associated with glass. Only 1% of the total number of units has a glass cover. Because of the required initial investment (glass is more expensive) it is somehow blocking the incorporation of high-tech items into mid-tech arched greenhouses, and this is harming, instead of helping, the Dutch Supply Industry (with the exception of the glass greenhouse suppliers).

Table 9. shows the classification criteria according to Kipp (2010). Kipp’s criteria concern only the production and do not consider the required investment. This classification, like most definitions, is arbitrary and static. In some aspects, the gap between medium tech and high tech is very wide. An example of this is the “root environment” item: the step between soil-grown crops and substrates with recirculation is big. In practice, many greenhouses, even those considered to be “high-tech” because of the external greenhouse structure, use substrates without recirculation.
Another definition is given by Lamas Nolasco (2010) in a FIRA information bulletin. FIRA’s study include in the definition of the Technological level, post-production activities such as packing and commercialization, and even technical and administrative assistance. (Tabel 10). Moreover, the technological level is illustrated with an average indicative investment. But he ignores the pest-control strategy among the production methods.
For comparison, SAGARPA’s definition is also based on costs per m^2 greenhouse (Table 10). If the costs with those given in Table 7. are compared, then big differences in the prices are visible: Sagarpa’s high-tech is more than 30 dollar per m^2 more expensive than that of FIRA, and what for SAGARPA is quoted as Medium Tech, is 10-20 dollar per m^2 cheaper than the low-tech by FIRA. Which confirm once more that the criteria to which the technology levels are classified differ among sources.

Table 9. Definition of high-tech and medium-tech greenhouses (Source Kipp, 2010).

Item	High-Tech	Medium-Tech
Roof-shape	Venlo (maximum ventilation)	Arched (multi tunnel)
Greenhouse cover	Plastic or glass	Plastic
Gutter height	> 5 m	4 - 4.5 m
Ventilation	Double ventilation, with insect netting	One side top ventilation and/or side ventilation, with insect netting
Screen	Movable high-radiation screens; energy saving screens are optional	None
Heating	Hot water boiler with natural gas, hot water storage tank and pipe rail system; the gas also supplies CO_2 to the crop	Gas burners in the greenhouse, above the crop
Cooling	Optional for hot season (spring, summer)	None
Climate control	Computerized; adequate knowledge of the crop-climate-technology system is absolutely necessary	Water control by simple time-based automated irrigation systems; temperature control by T-sensors in the greenhouse
Root environment	Hydroponics: substrates combined with recirculation of nutrient solution	Soil-grown
Integrated Pest Management	Possible when greenhouse is optimally controlled	Possible, but less effective because climate control is limited

Table 10. Definition of greenhouse technology level and required investment (Source Lamas Nolasco, 2010).

Technology level	High-Tech	Medium-Tech	Low-Tech
Investment	90-93 USD/m^2	53-59 USD/m^2	30-37 USD/m^2
Greenhouse	Dutch Venlo or multi tunnel, galvanized iron, polycarbonate walls, and one layered polyethylene roof.	Multi tunnel, galvanized iron, single or double layered polyethylene walls and roof.	Colombian of multi tunnel with black or galvanized iron, single layered polyethylene walls and roof
Heating	Close water circuit by a CO_2 generating boiler.	Air heaters (gas or diesel), Modine-type and ventilators	Air heaters (gas or diesel), Centinela-type and ventilators
Production process	Grafted plants, coco peat as substrate, CO_2 injection, climate control by “Priva”-software and fertigation	Non-grafted plants, volcanic substrate (“Tezontle”) of “agrolita”, fertigation with automated Venturi	Non-grafted plants, soil or sand cultivation, fertigation with manual Venturi
Packing	Electronic selection by colour and size, 2000 ton/year.	Mechanic size selection, manual colour selection, 500 ton/year.	No packing, no storage
Technical / administrative assistance	Technical advisor, con-sultant, account registers, certification BAP, BMP.	Local consulting, basic account registers.	No consulting or basic accounting.
Commercialization	Production agreed with brokers / major distributors in USA and Canada, national retailers	Major centralised local distributors, sometimes export complementing other suppliers (as outsourcers)	Direct sales or sales to local distributors.

Eric Viramontes Director-General of the AMHPAC, finds this definition extremely static and proposes a new division of the Mexican protected horticulture according to the level in which the construction intervenes the climate: according to him, we can talk about "passive", with small impact on climate, and "active" horticulture, where the greenhouse changes the production climate (Table 11). Products from passive and active horticulture have different productions (see 3.5) but they all reach the same markets; what matters is the quality that is produced, and the more active the technology level, the higher the percentage of the production that meets the highest export quality demands (US$ 1).

Table 11. Suggested classification according to the level of climate intervention (source AMPHAC).

Technology level	Active horticulture	Semi-active horticulture	Passive horticulture
Greenhouse construction	Plastic or glass	Plastic roof, net walls	Shadow house
Areas	Northern parts, Torreón, Cuahuila, Mexico, Jalisco	All of the country	Tropical areas (Sinaloa, Colima)
Production process	Hydroponics, climate control	Hydroponics	Soil
% US1 quality	90%	60 – 70%	40%

The differences between definitions are interesting, and might somehow illustrate the perception differences between Mexican and foreign investors. Compared to Kipp's definition, Lamas does not consider glass as cover material for high-tech, neither screens are mentioned. Soil cultivation is considered medium-tech by Kipp and low-tech by Lamas.

The Mexican Association of Greenhouse Builders AMCI use different terms and concepts to define the technology level of the greenhouse, based on the climate suitability and the investment level (see also Table 12 and Table 13). This definition is more in accordance with the definition suggested by AMPHAC. The three levels they distinguish are:

1. protective structures for "tropical climate" where the climate is like a natural greenhouse in terms of ventilation, light, temperature… the structure only offers protection against hale, insects and wind. To this category belong the shade houses with a simple fertilization pump (1 tank, one pump) and sometimes drip irrigation.
2. Protective structures for "temperate climate", the structure offers protection against the above mentioned weather factors and also against rain, moderate temperature differences. This are simple greenhouse structures with a plastic cover and net in the side walls or movable plastic side walls and drip irrigation.
3. Structures for "any cliate" include a more robust greenhouse structure with roofs that can open and close, a heating system, and some kind of automatized irrigation.

Comparing investment levels with the ones in Table 7, we can conclude that the AMCI members mainly build for the low-tech as defined by Lamas Nolasco, and the investment they require for their "tropical climate" structure is comparable to that of the Medium-Tech installations as defined by SAGARPA.

Table 12. Greenhouse investment costs according to the technology level (Source SAGARPA).

Technology level	High-Tech	Medium-Tech	Low-Tech
Description	fully automated	Semi-automated structures	simple elements or a shadow house
Required investment (peso m^{-2})	1,500	250	70
Required investment (US$ m^{-2})	127	21	6

Table 13. Greenhouse investment costs according to climate suitability (indirectly technology level, Source AMCI, 2009).

Climate suitability	Any climate	Temperate climate	Tropical climate
Required investment	29-38 (and higher) US$ m^{-2}	22–28 US$ m^{-2}	17-20 US$ m^{-2}

Definitions by Dutch sources also vary. A producers' survey by the Office of the Agricultural Counsellor of The Netherlands in Mexico (2010) provides different criteria for 'high tech' with regards to inclusion of CO_2 dosage and the presence of thermal screens. The elements mentioned in Table 14 that describe the high-tech installation were mentioned in different combinations.

It is not our purpose to define again the terms low-tech, medium-tech and high-tech. From the overview in this paragraph a number of elements can be extracted that are important in the discussion on the technology level:

- the physical and socio-economic climate in which the farm operates
- the modules of the construction
- the modules of the installation
- the continuum of changes, and the lack of precise boundaries between the levels
- the investments required
- the quantity and quality of production
- the level of integration with the value chain, and use of certification schemes
- the knowledge level
- the sustainability factors
- the availability of competent human resources for proper farm planning and management

If in the description of a protected cultivation system these elements are given attention, a fruitful discussion on the basis of common understanding is possible.

Table 14. Technology classification according to Dutch producers.

Technology level	High-Tech	Medium-Tech	Low-Tech
construction	Greenhouses	plastic greenhouses	plastic or net greenhouses
installation	hydroponics drip irrigation with fertilizers computerised climate control fertilisation heating by means of radiation tubes thermal screens CO_2 installation quality certification	- Hydroponics - Manual or computerised climate control by opening windows - air heating by burners	- No hydroponics - No climate control

3.5.2 Company size and technology level by State

AMPHAC conducted in 2009 an extensive survey among a representative number of growers in the States of Baja California, Sonora, Sinaloa and Baja California Sur, of which it was clear that they are active producers growing crops under protection. As it concerned a market study, the level of technology was not given much attention and even not precisely defined. Results of this study that were useful for our purposes are summarized in Table 15.

Sonora is dominated by medium-tech farms: metal construction, mostly substrate with fertilizer injection, heating systems and some presence of thermal screens. In Sinaloa a quarter of the farms is classified as high-tech. In Baja California, and Baja California Sur the low-tech farm type dominates. Metal constructions dominate, with some presence of wood constructions.

National data have been collected by SIAP within the National Information System for protected horticulture in 2010. These data are not as detailed as the AMPAC data, but they provide insight in the extent to which the different types of protection (greenhouse / net house / tunnels) are used for different states. It also provides some information on the use of substrates, irrigation systems and heating. No information is collected on energy sources, types of jobs provided, and more detailed greenhouse equipment information is lacking. Extra information as compared to the AMPHAC survey is supplied on the pest and weed control methods.

Table 16 and Table 17 show this information for 15 states, the above-mentioned states of Baja California, Baja California Sur, Sonora and Sinaloa plus 11 other states. The selection of states has been based on information collected by the Office of the Agricultural Counsellor of The Netherlands in Mexico (a big producers review, 2011): states for which this survey indicate to have High or Medium Technology greenhouses, have been processed in these tables.

Table 16 and 17 also give the percentage of the acreage having a size smaller than 10 ha. This shows that companies of more than 10 ha of protected cultivation are more an exception than a rule. Chihuahua and Durango are the only states in this selection showing a small percentage of the acreage in plots smaller than 10 ha, in the case of Durango, this is explained by the fact that 820 ha of the State's protected horticulture area belong to 2 huge companies. In Chihuahua, more than one third of the total acreage is used by farms between 10 and 40 ha, a third by farms between 40 and 80 ha. In Guanajuato, 9 companies have a size between 10 and 20 ha, in San Luis Potosí there are 7 companies with sizes between 10 and 30 ha, and only 2 companies are bigger than that. This could be explained by the % of total agricultural land that is in private hands: in the State of Chihuahua this is about 45%; in Guanajuato about 50%, and 70% and above are privately owned in Durango and San Luis Potosí (Ibarra and Morales, 1998).

It is not possible to relate these big companies directly to a product or technology level; however, by combining this information with that of the review by the Office of the Agricultural Counsellor of The Netherlands in Mexico, we can conclude that the large companies are mostly in the higher technological segment. Tomato is the most cultivated product by the bigger companies and almost the only crop in the states of Durango and San Luis Potosí. Pepper is cultivated by several large companies in Chihuahua and Guanajuato. Cucumbers are cultivated in Chihuahua and lettuce and seeds are present in big exploitations in Guanajuato.

Table 15. Characteristics and technological level of the exploitations in four States (source AMHPAC 2009). Note % is fraction of the enterprises providing data, not % of acreage!

		Sonora	Sinaloa	Baja California	Baja California Sur
	participating acreage	1200 ha	3272 ha	2878 ha	270 ha
	# of entreprises	85	105	107	17
	Average size of entreprise	13,8 ha	2% > 200 ha 40% 20-200 ha 58% < 20 ha	26.9 ha	15.8 ha
Technology level	Low tech	12%	25%	62%	75%
	Medium Tech	78%	50%	38%	25%
	High Tech	3%	25%	0%	0%
Greenhouse structure	Metal	95%	60%	100%	62%
	Wood	3%	20%	0%	38%
	PVC	2%	20%	0%	0%
Root media	Soil	40%	?	82%	50%
	substrate	60%	?	32%	50%
Greenhouse equipment	Fertilizer injection system	94%	23%	43%	
	Venturi	38%	11%	14%	
	Heating system	88%	11%	14%	
	Thermal screen	34%			
	CO_2 injector	9%	11%		
	nebulizers	3%	11%		
	automatization	34%	11%	5%	
Energy sources	Electricity	100%	100%	100%	
	Natural gas	30%	?	53%	
	Gas LP	11%	?	47%	
Water sources	Own deep well	48%	34%	30%	
	Communal deep well	66%	33%	27%	
	Irrigation canals	90%	33%	43%	
	Bassin	0%	0%		
Other facilities	Propagation area	88%	12%	19%	
	Cold store room	78%	11%	8%	
	Pre-cooling tunnel	46%	?	2%	
	Packing system	84%	11%	14%	
Soil possession	Own property	81%	36%	75%	
	Rented		18%	17%	
	Small property	68%	46%	58%	
	“Ejidal”	7%		42%	
Jobs generated	Total jobs	14.362	16.502	18.496	
	Agronomy graduates	240	655	293	
	External technicians	87	105	293	
	Indirect jobs	9.605	4.200	11.744	

Table 16. Characteristics and technological level of the exploitations in 8 States (source SIAP 2011). Note % is fraction of the enterprises providing data, not % of acreage!

		Sonora	Sinaloa	Baja California	Baja California Sur	Chihuahua	Coahuila	Durango	Guanajuato
registered acreage		1048	2490	2642	1142	1070	127	838	574
Nr. registered entreprises		586	1372	1297	494	197	155	180	633
Nr. Entreprises providing data		101	154	243	86	147	73	170	485
% covered by entreprises < 10 ha		100%		76%	96%	21%	100	2%	76%
Type of structure	Greenhouse	37%	60%	64%	28%	40%	56%	88%	87%
	Shadow house	61%	38%	30%	72%	4%	22%	1%	2%
	Shadow roof	2%	2%	1%	0%	55%	15%	1%	1%
	Microtunnel	0%	1%	2%	0%	0%	3%	8%	2%
	Macrotunnel	0%	0%	3%	0%	1%	4%	2%	9%
Greenhouse structure	Metal	98%	97%	96%	86%	47%	81%	96%	93%
	Wood	0%	2%	3%	1%	2%	6%	1%	0%
	PVC	0%	0%	0%	1%	0%	2%	0%	0%
Cover material	Plastic	45%	56%	55%	27%	27%	50%	83%	83%
	Glass	0%	0%	0%	1%	0%	1%	0%	1%
	Net	54%	44%	44%	64%	21%	28%	14%	4%
	Polycarbonate	0%	0%	0%	0%	1%	3%	1%	1%
Root media	Soil	90%	67%	81%	84%	32%	77%	65%	61%
	Inorganic substrate	0%	10%	12%	2%	5%	3%	23%	14%
	Organic substrate	6%	17%	3%	7%	2%	8%	6%	13%
Greenhouse equipment	drip irrigation	86%	70%	93%	84%	12%	80%	64%	72%
	sprinklers	3%	28%	4%	3%	30%	9%	22%	14%
	Automatized irrigation	5%	1%	1%	6%	3%	2%	4%	3%
	Heating system	22%	0%	2%	0%	15%	13%	13%	10%
	Mechanic ventilation	9%	28%	4%	8%	11%	15%	16%	9%
	Humid wall	3%	7%	0%	1%	3%	2%	1%	0%
Water sources	Deep well	65%	28%	89%	92%	37%	64%	33%	78%
	Natural source	18%	0%	0%	8%	0%	9%	9%	2%
	Drinking water network	6%	5%	2%	0%	2%	11%	47%	13%
	Bassin (presa)	10%	68%	0%	0%	4%	3%	9%	1%

		Sonora	Sinaloa	Baja California	Baja California Sur	Chihuahua	Coahuila	Durango	Guanajuato
Other facilities	Cold store room	20%	26%	22%	25%	23%	25%	0%	6%
	Packing system	23%	31%	37%	29%	8%	17%	33%	15%
	Classification system	23%	17%	7%	8%	8%	8%	0%	9%
Soil posesion	Own property	88%	90%	92%	99%	95%	75%	93%	78%
	Rented	8%	6%	4%	0%	1%	17%	2%	11%
	Borrowed	1%	2%	2%	1%	2%	3%	4%	6%
	"Ejidal"	18%	33%	46%	14%	17%	39%	19%	39%
Pest control	Chemical	46%	56%	52%	56%	53%	56%	71%	64%
	Organic	1%	0%	1%	0%	0%	5%	4%	2%
	Biological	36%	30%	25%	37%	42%	19%	14%	23%
	Cultural	17%	14%	6%	7%	3%	11%	5%	6%
Weed control	manual	50%	49%	50%	43%	32%	32%	59%	52%
	mechanical	22%	15%	3%	6%	47%	4%	2%	2%
	chemical	24%	26%	15%	8%	8%	3%	2%	6%
	Not controlled	4%	11%	32%	43%	14%	62%	37%	40%

Table 17. Characteristics and technological level of the exploitations in 7 States (source SIAP 2011).). Note % is fraction of the enterprises providing data, not % of acreage!

		Jalisco	Mexico	Michoacán	Nuevo León	Puebla	San Luis Potosí	Zacatecas
registered acreage		1581	559	637	91	299	780	305
Registered nr. Of entreprises		2134	1557	445	229	1564	784	501
Nr. Entreprises providing data		526	1421	583	220	1219	401	298
% covered by entreprises < 10 Ha		94%	88%	57%	82%	100%	69%	100%
Type of structure	Greenhouse	78%	22%	82%	100%	74%	58%	94%
	Shadow house	4%	0%	0%	0%	10%	29%	4%
	Shadow roof	1%	0%	0%	0%	0%	2%	1%
	Microtunnel	0%	37%	0%	0%	9%	5%	1%
	Macrotunnel	18%	41%	18%	0%	6%	5%	0%
Greenhouse structure	Metal	97%	84%	85%	99%	98%	81%	89%
	Wood	1%	15%	4%	1%	1%	7%	1%
	PVC	0%	0%	0%	0%	0%	0%	1%
Cover material	Plastic	84%	99%	88%	87%	78%	59%	83%
	Glass	0%	0%	0%	0%	0%	0%	0%
	Net	13%	1%	0%	10%	20%	27%	12%
	Polycarbonate	0%	0%	0%	1%	0%	0%	3%
Root media	Soil	70%	99%	42%	98%	62%	62%	60%
	Inorganic substrate	9%	1%	31%	0%	31%	11%	12%
	Organic substrate	12%	0%	12%	0%	5%	7%	23%

		Jalisco	Mexico	Michoacán	Nuevo León	Puebla	San Luis Potosí	Zacatecas
Greenhouse equipment	drip irrigation	81%	31%	43%	98%	82%	57%	61%
	sprinklers	6%	33%	3%	1%	4%	16%	31%
	Automatized irrigation	2%	1%	1%	0%	0%	8%	5%
	Heating system	1%	1%	1%	50%	10%	9%	30%
	Mechanic ventilation	4%	1%	1%	40%	1%	4%	7%
	Humid wall	0%	0%	0%	1%	0%	1%	0%
Water sources	Deep well	78%	11%	27%	98%	49%	68%	83%
	Natural source	9%	83%	36%	2%	32%	10%	4%
	Drinking water network	4%	0%	11%	0%	14%	10v	9%
	Bassin (presa)	6%	6%	9%	0%	1%	1%	2%
Other facilities	Cold store room	10%	11%	50%	20%	25%	11%	4%
	Packing system	22%	26%	0%	20%	25%	32%	25%
	Classification system	6%	19%	50%	0%	25%	16%	15%
Soil posesion	Own property	78%	92%	75%	98%	85%	82%	91%
	Rented	11%	7%	15%	1%	7%	4%	4%
	Borrowed	10%	1%	5%	0%	2%	3%	1%
	“Ejidal”	34%	42%	50%	6%	20%	35%	33%
Pest control	Chemical	60%	95%	76%	43%	87%	48%	71%
	Organic	1%	0%	0%	0%	2%	1%	1%
	Biological	30%	2%	23%	32%	5%	25%	15%
	Cultural	7%	2%	1%	24%	2%	15%	8%
Weed control	manual	64%	62%	64%	69%	55%	66%	48%
	mechanical	3%	0%	0%	0%	0%	4%	5%
	chemical	16%	8%	1%	1%	5%	6%	11%
	Not controlled	16%	29%	35%	29%	40%	24%	36%

If the acreages of and Table 17 are added, then a total of 14,183 ha of protected cultivation is reached. This might be an under-estimate, as the acreages given in Table 15 are higher.

A number of opportunities for the Dutch supply sector can be identified from these tables (with a great level of uncertainty given the detail level of the data and the inconsistencies between sources when applicable):

- Although most greenhouses are made of metal, it is worth considering the fundamental design. Temperature control, ventilation capacity, climate homogeneity are only some of the aspects that are normally worth a careful look. In Baja California Sur there are still wood greenhouses that might need replacement soon.
- Heating systems are not wide-spread, even in states where temperatures can be low. Opportunities might be in Sinaloa (see 3.5.2.1) Chihuahua, Coahuila, Durango, Guanajuato, Nuevo León and Zacatecas
- Although a large fraction of the growers in all states have a system for drip irrigation, only a very small percentage has an automatized irrigation system. This is surprising as in many states 20-40% of the growers switch from soil to substrate. Automation systems for irrigation could be an opportunity in all states, and specially in those where substrates are used by about ¼ of the enterprises as in Durango, Guanajuato, Sinaloa and Zacatecas.
- Biological pest control is already surprisingly high, with figures well above 20% in more than half of the states. Still, penetration can be much higher and offers opportunities in all states.
- Post-harvest management can be improved: cold stores, and packing and classification systems are not wide-spread, and might offer business opportunities in all states. According to the data, cold stores are totally lacking in Baja California, Durango, Sinaloa and Zacatecas; States without packing systems are Chihuahua and Michioacán.
- Good seed and good young plant material is needed in all States; the existence of a propagation area is only documented in the AMPHAC data (4 States); while in Sonora 88% of the enterprises have a propagation facility, this percentage is inverted in the states of Sinaloa and Baja California.

3.5.2.1 Enterprise size and technology level in the state of Sinaloa

Information about company size distribution in Sinaloa is lacking in Table 16. The AMPHAC data (Table 15) indicates that this is another of the states where big companies are active. In Sinaloa, more than 80% of the soil is in private property, which obviously provides an explanation. A "big horticultural companies" review by the Office of the Agricultural Counsellor of The Netherlands in Mexico (2010) is not exhaustive and some company information has not been actualized from 2007, but helps to a further fragmentation of the sizes categories beyond that of AMPHAC (Table 15), by showing that in the size category between 50 and 100 hectares at least 5 companies are active, another 5 companies are in the size category of 100 to 200 Ha, and only 3 exceed this size but are never bigger than 300 ha of protected cultivation.
A further analysis of the information to the exploitation level in Sinaloa reveals that this is one of the states where a certain transition is visible from soil cultivation to an increasing level of technology, as frequently soil cultivation still coexists with the predominant technology (plastic/net houses, qualified by most of them as "medium-tech" technology) and with "high-tech" and "Dutch technology" houses. The data do not deepen further the technological level.
The main product cultivated by the big companies in this state are, as showed in Table 4, tomato. There are however big enterprises specialized in other products, like pepper, cucumber and egg plant.

Chances are that the recent frost period gives an extra impulse to protected horticulture in the State of Sinaloa. In February 2011 night temperatures were registered that reached the -10 °C, while the long term average minimum for February is 12 °C (Instituto Meteorológico Nacional). This lead to tremendous economic losses, (CIDH CAADES, 2011) and many workers lost their jobs. The state of Jalisco benefited from this frost period according to different press releases.

3.5.2.2 Enterprise size and technology level in the state of Querétaro

Information on the technology level in the state of Querétaro is not given in the general SIAP survey neither in the AMPHAC survey. A survey by SIAP (2009) contained some information of the greenhouses location, and showed an average size of the Querétaro greenhouse of 0.5 ha. Information on technology level was lacking, however.

Very different is the situation in the Agropark[2]. The companies within the Agropark produce exclusively in high technology greenhouses according to the definition by Kipp (see Table 6.). The first established greenhouse has a glass greenhouse cover in a Venlo- type strong metal structure that can stand the weight of the vertically grown crop. The ventilation is by automatically controlled ventilators (roof windows), through insect nets that help to control pests inflight. By means of computer controlled energy and shade screens, energy loss through the roof and sunlight are controlled. The crop is cultivated in substrate on heightened gutters, and irrigated by means of a computer-controlled fertigation system, without *drainage water recirculation* (= chance for improvement and savings!). Heating and CO_2 are provided by means of a natural gas burning boiler that requires only 22 m^3/m^2year). A few greenhouses in Agropark recirculate and disinfect the drain water by means of a Ultra Violet disinfection system.

An automatic inner transport system, and automatic packing line, good storage rooms and an experienced manager complete the operation. Year round production is not economically interesting, because the prices in the summer go down when the buyers are served with product from Canada and the US. So between May and September there is no production.

Three enterprises outside the Agropark are listed by the Office of the Agricultural Counsellor of The Netherlands in Mexico (2010) with sizes varying between 3 and 20 ha each. The small company is considered to have Medium Technology, the other two high Dutch Technology in glasshouses. The biggest company was projecting expansion with 15 ha of high technology glasshouses.

An enterprise not listed is linked to the Training Centre CEICKOR, see 3.8.2.

2 Information provided by the Office of the Agricultural Counsellor of The Netherlands in Mexico (2010 list of companies), and obtained in two company visits.

3.5.2.3 Technology level in the state of Morelos

As mentioned before, the average size of the exploitations in Morelos is small, only 0.2 ha. Because of its relevance for the ornamental industry, we tried to obtain reliable data about the technological level of the growers in the state of Morelos. According to technicians by the FIRA development centre Tezoyuca, floriculture is an activity of low technological level but sufficient to generate investment capacity. 30% of the growers have an irrigation system, 10-15% use “a formulation”, which means that growers fertigate. Only a few growers use a measurement device for EC and pH, and most of them would not know what to do with the measurement results if they had one due to lack of knowledge. None of the growers is able to register temperature and relative air humidity. 30% of the greenhouse area has “bags” with substrate (tezontle); pest control is traditional (=chemical). Pesticide registration is not applied, although there are “certificados de producción vegetal”, whose meaning is unclear. Technological improvements are to be achieved mainly in the greenhouse structure and in the irrigation systems. Because of the benign climate, heating of the greenhouse is not necessary, so improvements in this field are not to be expected.

3.6 Productivity

Several sources provided information on the production obtained in the different regions for a few of the main crops. Figure 14 shows the yearly production in the states of Baja California North and South, Sonora, Sinaloa for the crops tomato, pepper and cucumber for the past 20 years. However, these figures show the total production, including open field and protected horticulture of all levels. The fraction of product from protected cultivation in the total is not indicated.

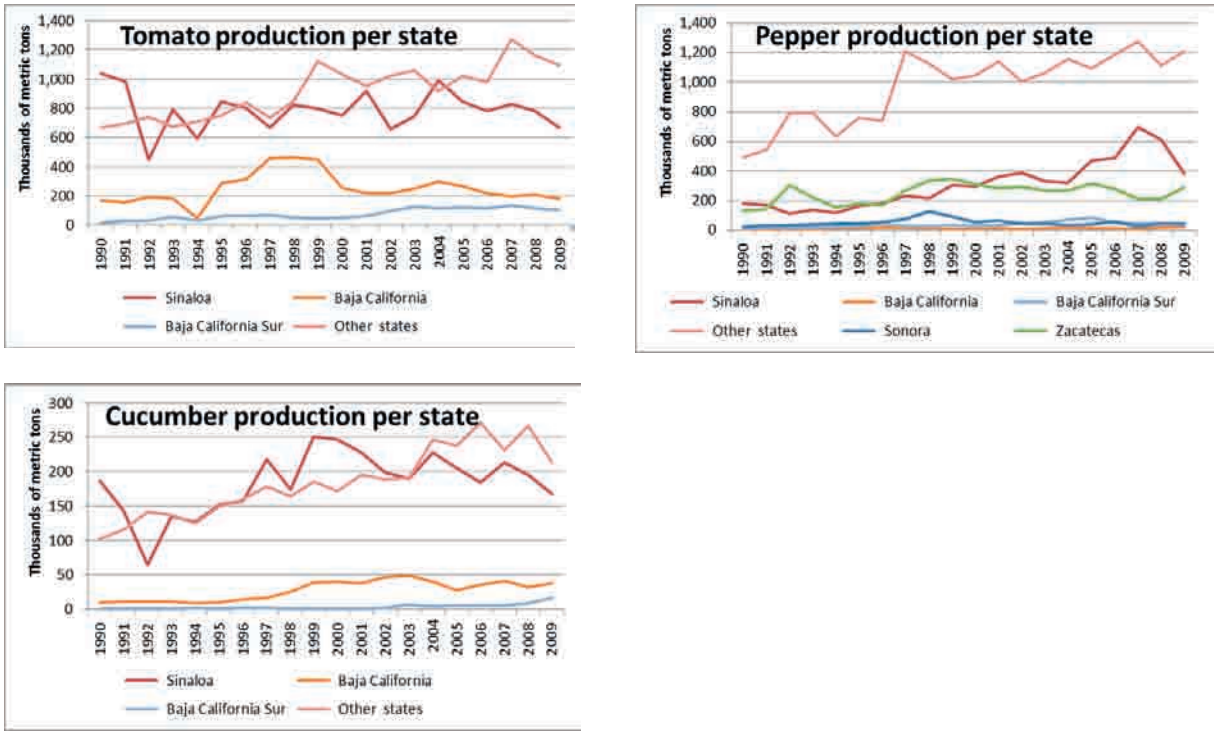


Figure 14. Production of three main vegetable products per state between 1990 and 2009 (SIAP, 2010).

Production levels are greatly influenced by the level of technology used in cultivation. Figure 15 shows that the production increases with technological improvement to the cultivation: protecting (plastic tunnels) -> heating -> the use of CO_2,-> the use of artificial light. Other factors affecting the production level are the period of the year during which the crop is cultivated, which is in turn very much affected by the level of technology, and the chosen variety.

AMPHAC compiled for their Protected Horticulture review yearly production data (in kg/m^2) from protected cultivation for the four states Baja California, Baja California Sur, Sonora and Sinaloa, also for the main products tomato, cucumber, pepper, and chillies. The data are summarized in Table 18. For comparison also the total average yields per state for crops (under protection and in open field) are given for 2009 (SIAP, 2011). Comparing these data with the data shown in Table 16 regarding technology level, it can be concluded that the lowest productivities (production per surface unit) are obtained in Baja California Sur, where the lowest technology levels are found.

As a reference, we have indicated in a second part of this Table 18, production rates for the same products in The Netherlands, but also in other countries with a technological development more comparable with that of Mexico (Southern Spain, Turkey), and for specific growers in Mexico. These last data prove that also in Mexico, the application of technological developments in greenhouses lead to comparable production increase, and this is important information to be used by Dutch suppliers of technology.

Table 18. Average production levels for four states in Mexico (kg m^{-2}; source AMPHAC 2009 (A) and SIAP (S)), and for other regions in the world (kg m^{-2} year^{-1}; various sources, 2011).

State	Tomato1			Cucumber			Chili pepper			Pepper2			eggplant	
	Protected		All	Protected		All	Prot.		All	Prot.		All	Prot.	All
	A	S	S	A	S	S	A	S		A	S			
Sonora	15.6	11.1	3.3	16.8	12.5	2.4	9.3		2.1					4.5
Sinaloa	21	12.4	4.5	16		6.0	6.8		3.4		6.2		7.5	4.2
Baja California	15.7	11.6	5.6	13.6	7.8	5.3	7.7	2.5	2.8	6				0.4
Baja California Sur	5.5	9.0	4.3		6.7	7.5	4	n.a.	2.7	6.8				1.7
Almeria3	14 -18													
Almeria4	47													
Netherlands5	64			80			Not applicable			30			53	
Netherlands6	76			88			Not applicable			31.5			58	
Queretaro7	608									229				
Michoacán10	24-31													
Turkey, Antalya11	25													
Turkey, Izmir12	50													

1 average of different types, including cherry (lower yield)
2 average of all colors
3 lower value corresponds to short cycle; higher value to long cycle
4 at EEFC research centre in passive (low-tech) greenhouses, no heating, natural ventilation but improved structures and crop management
5 yield in-between types (ex. Comeett) in regular greenhouses “high tech”
6 yield in-between types (ex. Comeett) in closed greenhouses “high tech +”
7 production level achieved by one company per product (personal communications)
8 double layered plastic greenhouses, heated, with climate and irrigation control, substrate , no CO_2 dosage
9 glass greenhouse, heated, with climate and irrigation control, substrate and CO_2 dosage
10 data from 4 growers with medium technology greenhouses (plastic multi-tunnels with substrate and fertigatio)n.
11 traditional passive greenhouses
12 modern greenhouses

Another factor influencing the production levels the varieties, especially in tomato, where there are many different types have a great influence on the production rates, which make more complicated to interpret the results obtained. In Table 13 (a) we have chosen for the big average; there where for instance cherry and cocktail types form a big part of the production will show relatively low productivities (Table 19) although they are cultivated in high technological level greenhouses.

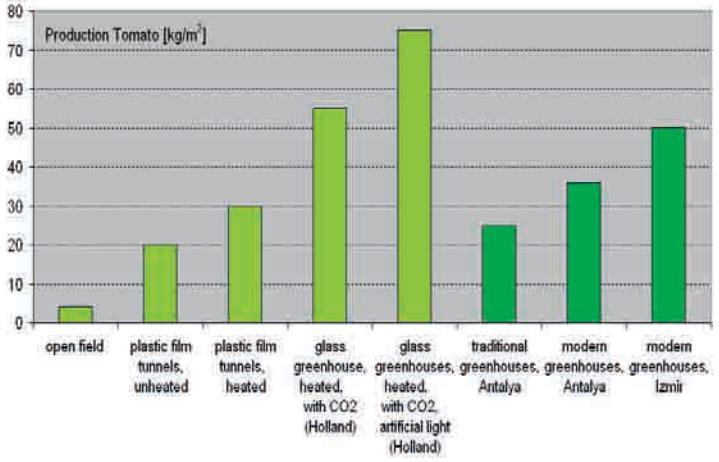


Figure 15. Increase in productivity as affected by the technology level, source Hemming and Maaswinkel (2010).

Table 19. Effect of the type on the productivity of tomato (Janse, J. Wageningen UR Greenhouse Horticulture).

Tomato type	Production in kg/m^2 (Dutch greenhouse conditions)
cherries	25-30
cocktail	40-45
most others	60-65

3.7 Horticultural policies

The development goals of the Mexican government are (SAGARPA, May 2011):

1. Integrated development through clusters.
2. Support of investment project oriented at the internal and external market, and at specialized niches (organics and gourmet).
3. Introduction of technologies and appropriate capacity building and technical advice.
4. Promotion of integration and development of actors into the value chain; permitting its harmonic operation towards consolidation as “cluster”.

To achieve these goals, the Mexican greenhouse horticulture receives substantial amounts of governmental subsidies (Table 20). From 2001 to 2008, SAGARPA subsidized 1,220 ha of protected agriculture for a total amount of 925.7 million MXN. The support was intensified from 2007 to 2008 with 1,401.1 million MXN for an additional 983 ha in 2007 and 420 ha in 2008. From 2007 onwards, subsidies were provided at the national level, with supporting programs at state level and from other federal ministries (SAGARPA, 2011).

In January 2009, the Strategic Project / National strategy for Protected Agriculture was launched. SAGARPA supports the development of protected agriculture under the “Support program for Investments in equipment and infrastructure”. This program falls under the National Development Plan 2007-2012. Its objective is to foment the production of healthy quality food, with focus on sustainable value chains and networks, through the production under protected agriculture. Subsidies are available for new installations, with a minimum of 50% of total costs or $ 3,000,000 MXN per agricultural production unit, with a maximum amount per hectare according to technology:

- For soil cover plastic, irrigation tubes, micro-tunnels: $100,000 MXN per hectare, up to $1,000,000 MXN per project.
- For macro-tunnels : $200,000 MXN per hectare, up to $1,500,000 MXN per project.
- For shade houses: $400,000 MXN per hectare, up to $2,400,000 MXN per project.
- For greenhouses: $1,200,000 MXN per hectare, up to $3,000,000 MXN per project.

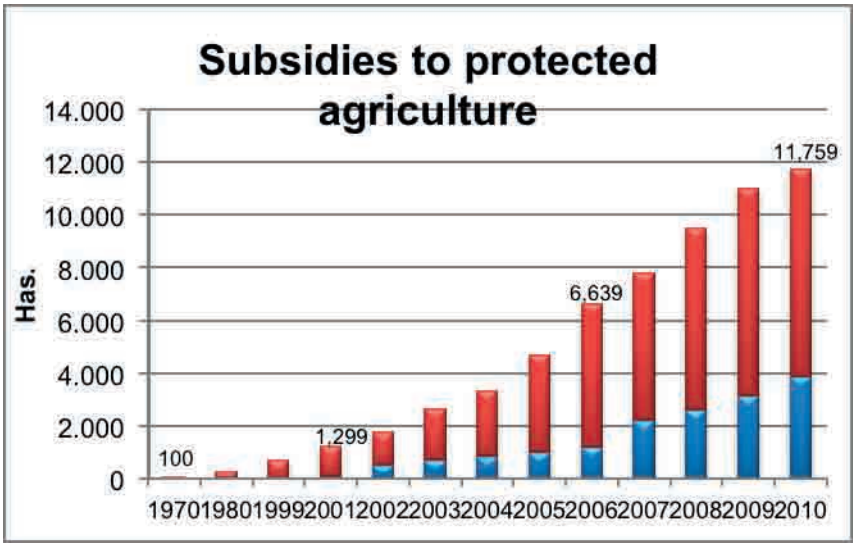
Furthermore, specialized training and technical assistance is electable for subsidy of 50% of total cost, up to $100,000 MXN. The same subsidy applies for insurance for greenhouses, market studies; production and market statistics, certification of good agricultural practices (GAP) and good manufacturing practices (GMP), and the promotion and diffusion of products originating from protected agriculture. In the case of new installations, a training course is mandatory for the producer. Plastic recycling plants of agricultural plastic waste are electable for a subsidy of 50% of total costs with a maximum of $3,000,000 MXN per project (Diario Oficial, 31-12-2010, section 5).

SAGARPA (Directorate of Linkages and Technological Development) authorizes the subsidies, FIRCO is the executing institution. Regarding the program, SAGARPA gives a list of authorized training institutes for which training subsidy can be applied (SAGARPA, 2011). See Table 21.

Concluding, as mentioned in the introduction of this chapter, governmental policies for horticultural development, though directed at all producers, put special emphasis on small-scale farm development as axe for development of rural areas. We have not found data on the distribution of public resources according to size or technological level of the enterprise receiving subsidy, credit or equity. In general, different segments are services by different financial institutions (see 3.9), but not exclusively so.

Table 20. Acreage of greenhouses established with subsidies. The embedded graph shows the same information the fraction (blue) of the total (red) acreage of protected cultivation established from 2001 with public subsidies.

Established acreage (ha) with SAGARPA subsidies (2001-2010)		
	Subsidized	Total
1970		100
1980		300
1999		721
2001	75	1,229
2002	523	1,798
2003	723	2,662
2004	844	3,362
2005	1,020	4,711
2006	1,220	6,639
2007	2,203	7,808
2008	2,623	9,502
2009	3,157	11,020
2010	3,896	11,759
Source: SAGARPA 2011		



3.8 Knowledge organizations

Most actors we spoke to for this study agree on the fact that the human development is one of the most acute needs of the industry. The development of the horticultural sector is only possible when the knowledge level develops together with the industry.

Because horticulture is a relatively new type of agriculture, a University Degree in horticulture does not exist yet in Mexico. Several knowledge organizations offer education for horticulture at different levels. Some of them officially qualify for subsidized training to growers at different levels (Table 16). Other institutes, like INIFAP and The Technological Institute Monterrey are part of the horticultural knowledge structure of the country.
The same applies for research in horticulture. There is not a consolidated research structure in the country to fulfil the questions and needs of the horticulture growers.

For this review, a visit was paid to two knowledge supply centres and interviews were held with three knowledge suppliers, of which a brief description complements the information shown in Table 21.

Table 21. Training institutes authorized by SAGARPA to qualify for subsidies.

Autonomous University of Chapingo, Texcoco, Estado de México	
	• Protected horticulture in Mexico • Introduction to hydroponic cultivation • Management of hydroponic crops in greenhouses • Introduction to management and operation of agricultural greenhouses
Colegio de Postgraduados (Postgraduate College), Montecillo, Estado de México	
	• Certificates and master degree in Agribusiness
Strategic Agribusiness Centre (CEA), Technological University Cancun, Colón, Quintana Roo	
	• Agribusiness advice for beginners • Greenhouse construction • Greenhouse horticulture production • Hydroponic management and production

FIRA - Technological Development Centres in Villadiego (Valle de Santiago, Guanajuato); Tezoyuca (Morelos); Tantakin (Tzucacab, Yucatán) and Salvador Lira López (Morelia, Michoacán)	
	• Protected horticulture and business development
Research and Training Centre Koppert Rapel (CEICKOR - for its acronyms in Spanish), Querétaro	
	• Greenhouse tomato production • Automation systems PRIVA • Specialized courses on greenhouse management
INTRAGRI, S.C. (Celaya, Guanajuato)	
	• Greenhouse cut flower production • Integrated plant management and integrated management of horticultural crops diseases. • Greenhouse horticultural crops • Greenhouse tomato production
CYCASA (Capacitación y competitividad Agropecuaria), Guadalajara, Jalisco)	
	• Diverse courses on strategic management, negotiation,human resource management, business plans, finance and fiscal regulations, etc.
Centro Regional de Servicios Integrales para la Agricultura Protegida (Tlaquepaque, Jalisco)	
	• Diverse courses in greenhouse horticultural crop production, hydroponics, environmental management of greenhouses, production of plant material, vegetal nutrition, interpretation of soil and water analyses, etc.
Centro de Innovación y Transferencia de Technológía “El Huevo (inaugurated Sept 2011), Villa de Arista, San Luis Potosí	
	• Diverse courses in greenhouse installation and operation at three technological levels (medium and high; shade housing, macrotunnels) climatological and fysiological control, horticultural crop production, hydroponics and fertigation, pests and diseases, post-harvest quality, etc.1
Centro de Desarrollo Tecnológico y Humano de Servicios Integrales para la Horticultura Protegida (Cedetech del Noroeste), Navolato, Sinaloa. In construction as result of demand by AMPHAC members, financed by Conacyt and SAGARPA	
	• Training and advisory servicios, certification in technology, markets; administrative, financial and, legal issues.

3.8.1 Autonomous University of Chapingo

Chapingo University is a public institution fully financed by Sagarpa, but in a small, growing percentage it is obtaining own income from technical courses. The new BSC program Horticulture (diplomatura) started 3 years ago in Chapingo, with a small Low technology greenhouse of 1 ha. The Diploma covers all aspects of greenhouse production in a 300 hour per year program.
Apart from this program, short training courses (about 40 hours) are being offered to professional technicians twice a year; they are open to all sectors, but it is mainly the Social Sector who is increasingly attending to these trainings. The trainings are given mainly in the following subjects:

- Protected horticulture
- Greenhouse management
- Introduction to hydroponics
- Management of hydroponics in a greenhouse environment

The main location is close to Federal District, but there are research units in Zacatecas, Yucatán, Oaxaca, Veracruz and Michoacán.

Chapingo students and staff do also perform research, in flower and vegetable cultivation. The university has a good reputation in the sector, though some people find it rather theoretical. They would benefit from stronger links with the sector.

3.8.2 Ceickor- Research and Training Centre Koppert Rapel, Querétaro

The centre is a joint venture of the private industry: Mexican Rapel (greenhouse constructor), 55% of the shares), Koppert (45% of the shares), and it is run by two growers with a lot of experience in cultivation in plastic covered High Tech greenhouses. Advise activities for starting growers helped them realise that there was a great need for education (capacitación). And this, in combination with production, has been what they have been doing for the past 4-5 years. 90% of the centre's income comes from production, 10% from advisory services and the trainings. Their unique selling point is that they are part of the exporting industry in big sized greenhouses and can offer real applied courses. Two of the trainers received this summer a capacity building course by a Dutch organization in The Netherlands.

Only this year (may 2011), they have already had 400 course attendants. They come from everywhere in Mexico and from Honduras, Guatemala. Most of them pay the course by themselves. Their educational level is very wide: from very low to very high.

The centre also works on strategic projects for the development of the national horticulture, as the use of renewable energies. Their advisory services go from the design of the greenhouse (the configuration) to the crop management, planning, management organization and support during the cultivation.

Their greenhouses are of double layered plastic, are warmed up by heaters (warm air blowers, called Ecoheaters, they work with gas), have Dutch climate and irrigation control, cultivate on substrate (cocopeat from Sri Lanka and a sort of local pumice called Tezontle). Recirculation of nutritive solutions is planned but still not implemented. CO_2 dosage is not considered necessary, since they ventilate profusely. They have now 2 greenhouses of 5000 m^2 and are building two more of 7500 m^2. They plan to grow also other products besides tomato: Pepper, cucumber.

Demonstration of good products and services in order to test them and adapt them to the Mexican circumstances is one of the derived goals of the centre. Soon two important seed companies will participate to show and test varieties. Anyone from the industry with a good product is invited to come and install it for demonstrating it to the Mexican growers; as an example, they mention Ludwig Svenson, who is going to install a shade screen (Mexicans think they are not necessary) to test it.

They export through a commercializing company of which 3 other growers are member; the other members account for 30-40 Ha in Zacatecas, Michioacan, Guadalajara (5 ha in Monterrey).

Their advisory services go from the design of the greenhouse (the configuration) to the crop management, planning, management organization and accompanying during the cultivation.

Ceickor is increasingly being accepted and listened among by SAGARPA. In this kind of services, the Centre seems to meet the needs of the industry. They have obtained in the short time that thy are operational, a good reputation as practical trainers, and trainers from other centres (like the FIRA TDC's, see below) send their more advantaged growers. Their target group is the grower in the Middle-high technological level.

The concept might be interesting for other regions in Mexico as a show-case for Dutch Technology.

3.8.3 FIRA - Technological Development Centres

FIRA's mission is to promote the development of the rural sector through two main pillars: financial support (subsidies and credits, (see chapter on Financial institutions) and technical support. For this last, 30 centres were created in the past, of which only 5 are active, 2 of them in horticulture: Michoacán and Morelos.

The TDCs target the small to medium producer; producers more developed are sent to CEICKOR (see above) for courses. They teach growers through courses, workshops, demonstration days, guided tours and observation trips, and produce on a very small scale. In 2010 the Tezoyuca centre received 720 visitors and course attendant, from different states (México, Morelos, Hidalgo, Puebla, Guerrero, Veracruz, Oaxaca, Tlaxcala). 90% of these courses/ workshops are financed by the institution, 10% is paid by the participants.

Their strategy for 2011 is to try to bring the average grower to a higher technological level, for what they use a network of technical advisors specialized in protected horticulture. Among their efforts, they are trying to map the tomato production in greenhouses; the area of Morelos produces 60.000 ton and occupies the 4th place in sales (after maize and sorghum).

Among their installations, they have net houses with hose-irrigation, plastic greenhouses with pad fan cooling system, a tissue culture laboratory (in which they propagate endemic species), and rooting and hardening areas (greenhouses) for teaching, selling and advisory purposes.

The centre could develop further and play an important role in the upgrading of the horticultural sector in the areas where they are active, if they would have access to better technology and become a model for the growers to imitate.

The centre in Michoacán has done extensive studies on production costs.

3.8.4 INIFAP

The National Institute for agricultural, forestry and livestock research is a governmental organisation (belongs to SAGARPA) with presence all over the country in 8 regional research centres and 5 National Centres for Disciplinary Research. Some of the centres have greenhouses for research and training purposes.
We could not visit any of the centres during our visit. Although they seem to enjoy a good scientific reputation, there is discussion about their practical relevance for the industry.

3.9 Financial institutions

State reports on finance for the improvement of protected agriculture (credits and subsidies) mention three main financial sources directed at protected agriculture: FIRA, FIRCO and Financiera Rural. FOCIR also finances high technology projects on greenhouses through FICA's.

3.9.1 FIRA

The Trust Funds for Rural Development (FIRA) was established in 1954 by the Mexican federal government. It is a second-tier development bank that offers credit and guarantees, training, technical assistance and technology-transfer support to the agriculture, livestock, fishing, forestry and agribusiness sectors in Mexico. FIRA has a network of 143 offices throughout Mexico, more than 40% of which are based in communities with fewer than 50,000 residents. Besides its headquarters located in Morelia, Michoacán; FIRA counts with an office in México City; 5 regional offices; 31 state offices and 100 local branches.

As a second tier financing organisation, FIRA offers financing of projects through Banks and Non-bank financial institutions, like "Cajas de Ahorros", Credit Unions etc. Currently (interview Ing. Sánchez Mújica) FIRA canalizes more than 9.000 millions of Dollars (60% of all agricultural credits). These credits are supported by a guaranty fund for these credits, in which they share the risk with the bank. Guaranties can reach as much as 90% of the financed capital for the very small growers.

FIRA finances "hardware" (greenhouse and equipment); production means (labour, seeds/plants, fertilizers, pesticides, etc); as well as advisory services (independent experts are financed up to 70% of their cost). The program of Technical Assistance is an important part of services for small and medium scale producers ("social sector"), directed at the "Medium Tech Horticulture" with an average investment of (30 US$/m^2). For this purpose FIRA has five "Centres of Technological Development", of which two are oriented at Protected Horticulture (Morelia and Cuernavaca). These centres support growers with practical knowledge, through workshops, courses, seminars. Sinaloa is a very important area in number of projects presented.

Besides vouchers for training and assistance related to technology development, FIRA uses subsidies to encourage long-term financing in Mexican pesos to small agricultural producers at favorable rates offers, by covering the difference between the rate charged to financial intermediaries by FIRA and the lower rate they eventually charge the end borrower. Likewise, FIRA convers transaction costs incurred by serving those with low credit levels.

3.9.2 FIRCO

The Shared Risk Trust Fund FIRCO (Fideicomiso de Riesgo Compartido) is a parastatel entity, and executive arm of programs by the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA. Its objective is to promote agribusiness, rural development and to act as micro- technical staff in programs of agricultural and fisheries sector. The institute provides both credits and subsidies. It operates the National Strategy for Protected Agriculture. FIRCO is based on the concept of risk-sharing by channelling additional financial resources to the rural sector that minimize the risk involved undertake investments for the strengthening and diversification of production chains. In 2011 FIRCO operated several programs, of which one is dedicated to protected agriculture.

3.9.3 Financiera Rural

Financiera Rural began operations in 2003. It aims at increasing productivity and profitability in rural areas, through the use of two fundamental tools: loans and the provision of training, advisory and technical assistance services. After almost seven years of operation, Financiera Rural has granted more than 500 thousand rural loans, totalling over 7 billion USD. Financiera Rural is a first and second tier lending institution, which allows is to grant credit to individual rural producers and entrepreneurs, as well as rural enterprises, rural financial intermediaries and informal credit organizations, through 97 branches located throughout the country.

Finaciera Rural also gives subsidies for the construction of green/shade houses. This enables farmers without collateral (proper capital) to use the subsidy as the 50% contribution needed to obtain a 50% credit of the cost of the whole project. Credit is given with an yearly interest rate of13% for 3 or years, with amortization postponement of 1.5 year. In comparison, FIRCO also finances 50% of total costs of a protected agricultural Project; but the farmer will need own capital. In practice this means that a farmer needs an average of 1.5 million pesos to establish half an hectare of low tech greenhouse / shade house financed by FIRCO.

3.9.4 FOCIR

The Capitalization and Investment Fund for the Rural Sector (FOCIR for its Spanish acronym) is a governmental institution created to promote investment in the rural and agribusiness sector. It began operations in 1993. Since August 15th 2008, FOCIR operates as a Specialized Financial Agent for the rural and agribusiness sectors, thus no longer belonging to the Public Trust Funds that form part of the "Financial Banking System" with its rigid banking regulation. According to FOCIR, it enables the institution to be flexible to respond fast to the needs of the Capital Market.

FOCIR does not offer loans as its main activity. As a second tier financial institution (representing the Mexican Government) it creates and operates private equity funds. One of those instruments are the Agribusiness Capital Investment Funds (FICA for its Spanish acronym), a trust fund built up as a private entity with mixed capital participations: 45 to 65% by private investors; federal government (FOCIR) up to 35%; 20 to 25% by states governments.
Examples of FICA for the development of greenhouse supply chains:

- Hortícola FABRA, S.A.P.I. de C.V. Producers of high quality greenhouse Bell Pepper in Sonora's Mayo Valley. FICA´s investment in the company sums $ 30.030 million pesos MX (56% of total equity), under a tripartite investment structure.
- Santa Maura Importaciones México, S.A.P.I. de C.V. Distributes and commercializes chilli peppers, nuts, dry fruits and grains with 15 points of sale in the north of Mexico. FICA's investment is $ 114.286 million pesos MX (83.12% of total equity), for the expansion of 21 new points of sale in the south and north of the country, under a bipartite investment structure.

FOCIR manages various governmental and private Investment Programs geared for SMEs, across all sectors of the economy, such as the Ministry of Economy's Development Program for SME´s. Additionally, to promote Private Capital Investment in our country, FOCIR is partner with NAFIN.

3.9.5 Summary

In general, the different financial institution service different producer segments. Roughly speaking, the low technology farm segment in horticulture is targeted with the governmental policies by SAGARPA (FIRCO, ASERCA, Financiera Rural). Recently these have become more successful through improved market orientation (with focus on clustering). The social objective of these institutions (prevention of migration from rural areas) are as important as financial performance.
FIRA targets both the low technology segment as the more commercial farmers, already integrated in the market, with medium to high technology. Finally, FOCIR targets medium to high technology farms; they specifically promote the concept of agro-parks with the integration of large agri-businesses.

3.10 Professional organizations

3.10.1 AMCI

The Mexican Association of Greenhouse Constructors AMCI started in 2005 as a professional organization for greenhouse builders and constructors Initially, 24 greenhouse builders participated, and currently the association has 50 members, of which 11 members are suppliers of materials: steel, plastic, nets, nutrients, etc. The association is supported by membership fees. The association has Honorary members that offer technical assistance.

The association actively participates in the main Horticultural events in Mexico, and has organized international symposia, as well as a yearly event to promote their activities. They have good links with the governmental bodies that define support programs and provide growers and associates with information about economic resources for new greenhouse projects. Among the most important achievements of the association, a norm for the construction of greenhouses has been developed (NMX-E-255-CNCP-2008) together with a certification program for greenhouses, in order to ensure the quality of the materials and the equipment. The aim of the organization is that in the near future, only certified builders according to this Norma Mexicana can qualify to build projects for which public subsidies, credits of other support means are involved.

3.10.2 AMHPAC

The Mexican Association on Protected Agriculture (AMHPAC) is a non-profit organization representing 150 firms that are associated with the production, packing, distribution and marketing of fresh horticultural products cultivated in greenhouses, shade houses and macro tunnels in Mexico. The membership covers 23 states of Mexico, with an extension of 3,800 hectares and a yearly production of 1,050,000 metric tons, representing 66% of all exports of horticultural exports to the United States and Canada (Campaña Acosta, 2010)

3.11 Sistemas Producto

The constitution of the Sistemas Producto (Product Systems) is one of the strategies by the Mexican government to strengthen and develop a new organizational culture in agribusiness extending into the rural sector.[3] It was established by law in 2001 (Law of Sustainable Rural Development, art. 179 and 180) to improve the competitiveness of Mexican market chains and to facilitate a more efficient marketing of rural agricultural products, with larger retention of economic surplus by the primary producer. It is based on the assumption that the competitiveness of one part of the chain will affect the competitiveness of other parts of the chain, putting at risk the whole chain. In the chain, agribusiness transmits market requirements for products backwards (upstream) into the chain: what to produce, how much to produce, and of what quality.

The different governmental levels (state, regional and national) function as facilitators and normative partners, creating administrative packages of risks in insurance and hedges to provide economic certainty to the various parties: producers, agro-industry and marketers. SAGARPA supports the Sistemas Producto, in coordination with the Ministry of the Economy, amongst others through financial support to the field and the creation of the physical and futures agricultural markets. A specific program is directed at the strengthening of the Sistemas Producto by covering 50% of the costs of designing strategic plans, participation in congresses, seminars etc.

The product system operates through committees. The committees take charge of planning, communication and permanent consultation between economic actors of the production chains: producers, industrials, marketing companies, service providers etc. Producer councils and State committees are the basis for regional and national integration.

3 http://www.hortalizas.com/ehortalizas/protection/?storyid=2331

In the case of tomato, the National Committee was established in April 2010 by nine State Committees, representing about 1,500 producers. Its objectives are congruent with those stipulated in the Law for Sistemas Producto:

- Increasing the sustainable profitability of the tomato.
- Diversify export markets.
- Raise the competitiveness of the productive chain of the tomato.
- Raise the standard of living of all the economic agents of the tomato.

Activities include marketing, good agricultural practices, certifications, training, care of the environment, and the establishment of an insurance fund to protect the investments of the producers.

Morelos was the first state to establish a state Sistema Producto (2007), followed by Sonora, Chiapas and Baja California) in 2008; San Luis Potosí, Guanajuato and Michoacán in 2009 and Puebla and Sinaloa in 2010. Six other States are in the process of organization.[4] Amongst the states, Sinaloa[5] is recognized as being more advanced in the development of the productive chain, motivating them to seek an agreement with the Confederation of Farm Associations in the State of Sinaloa (CAADES), to raise the competitiveness of this chain. In ornamentals, the National Committee of State Sistemas Producto is organized in the Consejo Mexicano de la Flor (CONAFLOR), consisting of state committees for ornamentals from Baja California, Colima, Chiapas, Morelos, México State, Jalisco, Mexico Federal District, Michoacán, Puebla and Yucatán).[6] Feria Habitat Verde[7] also mentions Sistema Producto de Ornamentales Guerrero as an exhibitor.

As was indicated for the Sistema Producto (red) tomato; the Sistemas Producto will mostly be successful if integrated by market actors already operating integrated value chains.

Competent human resources will accelerate technological development. People from the sector have commented that the revenue of a horticultural farm not only depends on the (product specific) technology it operates, but also on the operation of proper planning and management systems improving yields per square meter. There is a lack of medium and high level managers to operate more advanced horticultural systems. Dutch knowledge and training institutes are already supporting training centres in Mexico, these initiatives can be strengthened into proper knowledge system infrastructure (module and product based).

3.12 Quality labels and certification

3.12.1 Product certification

Food safety standards for export-oriented producers are essential. This is not the case for producers oriented to the domestic market. Table 22 shows that according to SIAP and AMPHAC surveys, a great number of the vegetable production companies are certified (Table 22). Again the main difficulties for interpretation lay in the great discrepancies observed between the information sources, presumably affected by the number of entreprises participating in the survey, lower in the AMPACH survey, according to which, Baja California Sur with a low technology level, no growers from the 17 participating are certified. The bigger sample based survey of SIAP is more recent and covers more states. According to it, with the exception of the state of Mexico (mainly ornamentals produced and therefore less relevant), at least a third of the Mexican growers has a Good Agricultural Practice certification, varying per state between 18% in San Luis Potosí and 87% in Nuevo León. Export certificates are owned by 0% (Chihuahua) to 30% (Jalisco) of the growers, and Food Safety programs are implemented by 10 to 50% of the growers.

4 http://www.tomatenacional.com.mx/?q=node/1
5 http://www.tomatenacional.com.mx/?q=node/1
6 http://www.conmexflor.org
7 http://www.feriahabitatverde.com

Table 22. Certification systems for 15 states, according to 2 sources.

	Nr of entreprises	Certification (source SIAP-SAGARPA 2011)			Nr of entreprises	Certification (source AMPHAC 2009)			
State		GAP	Export	Food Safety		GAP	Mexico Calidad suprema	Food Safety	Export (ISO 9000)
Sonora	101	33%	19%	44%	87	50%	6%		
Sinaloa	154	39%	21%	34%	105	9%	9%	9%	
Baja California	243	42%	12%	36%	107	42%	12%	36%	100%
Baja California S.	86	32%	14%	44%	17	0%	0%	0%	0%
Chihuahua	147	27%	0%	55%					
Coahuila	73	29%	29%	43%					
Durango	170	50%	17%	17%					
Guanajuato	485	30%	16%	46%					
Jalisco	526	36%	30%	29%					
Mexico	1421	0%	26%	39%					
Michoacan	583	52%	6%	37%					
Nuevo León	220	87%	3%	10%					
Puebla	1219	46%	12%	35%					
S. Luis Potosí	401	18%	12%	33%					
Zacatecas	298	43%	4%	50%					

As Food Safety programs require significant investments (to accomplish with the program can amount to about 9% of the total production costs, Avendaño et al., 2007) and are a barrier for the export market penetration, they are presumably associated with the bigger surface exploitations and the higher technology levels.

There are several food safety systems accepted by the GFSI, Global Food Safety Initiative, recognised by seven big retailers, one of them is the Dutch HACCP (Hazard Analysis and Critical Control Points). Dutch technology and cultivation methods and the knowledge of the HACCP system could be seen as an opportunity to increase the chances for certification.

AMPHAC signed in 2010 a cooperation agreement with a consulting company in an attempt to impulse the Safe Quality Food (SFQ) program, also recognised by the FAO, and the FDA (Food and Drug Administration) in the United Stated of America (press release www.2000agro.com), and the above mentioned GFSI.

Mexico Calidad Suprema is an official governmental brand supplied to entreprises that comply with quality standards, food safety standards and good agricultural practices.

3.12.2 Greenhouse Quality norm

There is a need for regulation and qualification of the greenhouses. (Eric Viramontes , AMPHAC). Together with the AMCI, the association of constructors, the Association has worked on a norm, the “NORMA MEXICANA NMX-E-255-CNCP-2008 “: This is a technical document that regulates the procedures for design and construction of greenhouses, in every Mexican region. It ensures that greenhouses comply with minimum requirements in terms of mechanical resistance, stability, durability, foundation, etc. for plastic covered structures. The norm does not include regulations for the construction of access to the greenhouse, like paths, stairs, etc. At the moment, only two greenhouse building company are certified; the certification process is in progress for 10 companies. The newest agricultural policies will include the prerequisite that, to have access to subsidies, growers build only certified greenhouses according to this norm.

4 The market

In this chapter we look at the main markets for Mexican vegetables. Though in Mexican trade statistics no distinction is made between open field crops or green (shade) house crops, the example of the tomato market shows that production from protected agriculture is growing in importance in the end market for fresh product. The main four vegetable crops that are exported by Mexico and that are produced under cover, are tomato (roma, beef, cherry, TOV = tomatoes on the vine), peppers (chile and bell), cucumber (pepino) and squash (calabacita) in case of vegetables; and roses, gerberas, tulips and lilies in the case of ornamentals. Sagarpa estimates that 70% of all greenhouse cultivation is dedicated to tomato[8]. According to AMPHAC (Campaña, 2009), from 2003 to 2008; exports originating from protected agriculture has grown in importance from 6.6% to 31.5% of all exported volume; in value products from protected agriculture increased from 10.5% to 49%, while the price at the US border of all exports from protected agriculture is 54% higher than open field products.

4.1 Vegetable exports by Mexico and destination markets

Practically all vegetables that are exported by Mexico go the USA (Table 23). Main competitors for the US market are Canada and the USA domestic producers. In the USA and Canadian markets for fresh vegetables, Mexico is market leader. Mexico supplies to the USA 85% of the tomatoes (the rest mainly coming from Canada), 66% of the peppers and 70% of the cucumber (Table 24).

Table 23. Vegetable exports by Mexico to the main destination markets, in 2010, in US$. (Source UN Comtrade).

Country of destination	Trade Value	Relative value
World	4,324,074,125	100%
USA	4,116,506,762	95.20%
Canada	41,358,250	0.96%
Spain	29,728,913	0.69%
Guatemala	22,627,489	0.52%
El Salvador	15,699,740	0.36%
Japan	14,568,862	0.34%
Algeria	11,020,933	0.25%
Turkey	10,914,139	0.25%

4.1.1 Mexican vegetables export sector

The rapid growth in Mexican exports to the U.S. have been driven by growth in consumption of key crops like tomatoes and other winter vegetables, mangoes, grapes, avocados, and in some cases due to new crops, e.g., berries. The export outlook for Mexico continues to largely depend on U.S. demand trends, which have been generally favourable – but crop specific. Seasonality drives shipments and trade in fresh produce and Mexico has always had climatic advantages over U.S. fresh produce supply. This will not change.

8 Press communiqué Sagarpa 16-1-2009

Table 24. Mexican exports of vegetables, grown in greenhouses and in open fields, in 2009, in 1,000 US$ (SAGARPA 2011).

Product	Total	% of total production	USA	Import share Mexico1	Canada	Import share Mexico1	Other countries
Tomato	1,121,662	42%	1,112,541	85%	9,081	46%	40
(Bell) pepper	616,118	23%	613,692	66%	2,411	40%	15
Squash	448,498	17%	438,558	85%	6,039	25%	3,901
Cucumber	297,231	11%	297,053	70%	178	67%	-
Strawberry	99,179	4%	99,160	97%	4	4%	15
Eggplant	54,096	2%	54,041	85%	55	86%	37
Celery	18,020	1%	17,896	70%	96	2%	28
Radish	15,733	1%	15,366	62%	362	20%	5
Spinach	5,200	0%	4,981	68%	219	2%	-
Raspberry	3,295	0%	3,040	87%	71	36%	184
Blueberry	972	0%	961	1%	0	0%	11
Total:	2,680,004		2,657,289		18,516		4,236
1 Share of Mexican product in the corresponding imports by the United States and Canada							
Source: SAGARPA with data from the International Trade Center							

Table 25. Per capita consumption of some fresh vegetables in USA and Canada.

		2000	2009	change
Pepper	USA*	3.71	4.46	20%
	Canada	3.23	4.39	36%
Tomato	USA	8.61	8.89	3%
	Canada	7.72	7.43	-4%
Cucumber	USA	2.88	3.08	7%
	Canada	3.95	4.76	21%
* Fresh and processed bell peppers				
For USA farmweight; Canada: retail-weight				
Source: For USA calculated by USDA, Economic Research Service; for Canada Food Statistics, Statistics Canada, Cat. no. 21-020.				

Table 26. Export value of main edible vegetables from Mexico, in 1,000,000 US$ (Source UN Comtrade).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total edible vegetables	2,176	2,330	2,244	2,614	2,997	3,122	3,479	3,558	3,869	3,694
Accum. growth		7%	3%	20%	38%	43%	60%	63%	78%	70%
Tomato	495	532	609	868	909	881	1,119	1,069	1,205	1,211
Pepper and chilli	361	422	351	425	577	599	584	609	624	563
Onions & shallots	179	165	159	182	214	285	223	241	301	277
Cucumbers and gherkins	175	191	194	262	343	284	381	410	421	261
Cauliflowers and broccoli	35	32	36	25	34	38	46	47	56	80
Aubergines	35	39	36	37	55	49	42	52	54	51
Others	897	948	858	814	865	985	1,084	1,130	1,208	1,251

Table 27. Destination market of vegetable production from protected cultivation in 15 states according to 2 sources.

	Markets of product destination (source, SIAP-SAGARPA, 2010)						Markets of product destination (source, AMPHAC, 2009)				
State	# enter-prises	Local	Estate	National	Export	Subsist-ence	Local	Estate	National	USA	Canada
Sonora	101	16%	2%	30%	49%	1%	50%	6%	62%	93%	34%
Sinaloa	154	14%	1%	23%	33%	26%			25%	37%	38%
Baja California	243	13%	4%	17%	43%	5%	6%	15%	15%	46%	8%
Baja California S.	86	16%	2%	18%	55%	9%		6%	12%	81%	19%
Chihuahua	147	25%	6%	66%	1%	3%					
Coahuila	73	35%	5%	28%	14%	8%					
Durango	170	83%	5%	1%	0%	4%					
Guanajuato	485	47%	17%	17%	12%	2%					
Jalisco	526	46%	22%	10%	18%	1%					
Mexico	1421	53%	24%	20%	1%	0%					
Michoacan	583	47%	21%	24%	5%	1%					
Nuevo León	220	11%	6%	41%	40%	0%					
Puebla	1219	46%	31%	19%	1%	2%					
S. Luis Potosí	401	48%	15%	14%	4%	9%					
Zacatecas	298	44%	9%	23%	8%	11%					

Most states are linked to the international export market, although the export orientation varies considerably (Table 27). Sonora, Sinaloa, Baja California, Baja California Sur and Nuevo León are most export oriented, while the other states are more predominantly serving the local and national market.

The fresh vegetable consumption per capita in the United States in 2010 was 77 kilo farm weight, having grown with 50% from 51 kilo per capita in 1980. In Canada fresh vegetable consumption is stable: in 1997 per capita consumption of fresh vegetables was 75 kilo, in 2009 84 kilo.

Figure 16. Fresh fruit imports and exports for the USA. Source Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics (product group FAS).

The state of Sinaloa is the largest Mexican exporter of fresh produce, followed by Baja, Sonora, central Mexico, and Michoacán for avocados. The leafy green sector is not an important exporter from Mexico whereas exports of 6 winter vegetables from the state of Sinaloa are: tomatoes, bell peppers, cucumbers, eggplant, sweet corn and squash. This is the identical product line as in Florida, which is the direct competitor. California does not produce those crops during the winter (market window). Sinaloa's competitive advantage is that it rarely freezes during the winter whereas the competing region in north America, Florida, has a much higher freeze risk. In addition, it has large grower-exporters, many of which are well-capitalized, rapid technology adopters, efficient, with strong food safety programs, and several of which control their own marketing.

The competitive advantage of relative cheap Mexican labour in comparison with the U.S. industry does not hold for fruits and vegetables, as these are more intensive in information/knowledge, technology, capital and marketing, than in labour. In marketing, the U.S. has traditionally held the advantage. However, Mexican competitiveness increases with the development of Mexican protected culture of key export crops: tomatoes, sweet peppers, and cucumbers; these are also knowledge- technology- and capital-intensive. As said, this causes labour efficiency to increase. Formerly large open-field production areas like Sinaloa and Baja California are converting growing shares of their area to protected horticulture, causing acreage and employment to decline for any given production volume. In Sinaloa veg area declined by 23% over the last decade while production was similar (Cook, 2011).

Yet Mexico still lags in marketing and logistics. Mexican export marketing is still too fragmented, with smaller players marketing through brokers which can be disruptive to markets. Furthermore, security concerns are increasing costs and decreasing logistical efficiency

Changes in the US supply chain causes Mexican competitiveness to improve, as U.S. grower-shippers start playing a greater role in the sourcing and marketing of Mexican fresh produce (including in some cases joint ventures in packing sheds, not just production). Some retailers are attempting to import directly, led by Walmart.

Major export by road shipping ports at the Mexican – American border are Tijuana (27%); Nogales (45%) and Nuevo Laredo (15%). The main route for Baja California for export is through Tijuana (to San Fransico). Sinaloa (Culiacán) uses both Nogales and Nuevo Laredo as shipping ports, while the more centrally located states (Jalisco, Michoacán, Morelos, Veracruz) ship through Nuevo Laredo.

4.2 Tomato market

Mexico's export of edible vegetables has grown in value in the last decade. Large part of the growth is explained by the growth of export of fresh tomato with 145% since 2000. The yields of tomato have known an increasing trend in the last decade, both in volume per ha as in value per metric ton (Table 24, Table 26). Tomato is now responsible for 33% of the total Mexican exports of vegetables, against 23% in 2000. Table 23 shows that the USA is Mexico's natural market, due to the North American Free Trade Agreement (NAFTA) between the United States, Canada and Mexico, established in January 1994, which has lifted trade tariff barriers between the three countries.

Seasonality is a major force affecting the North American fresh tomato industry, both greenhouse and field tomatoes. In winter, field tomatoes are only available from Florida and Mexico. Over time, the industry has developed relationships that cross national borders and provide a relatively seamless supply of field tomatoes from different regions across the seasons (Figure 1.). While greenhouse tomatoes can be grown anywhere at any time of the year, issues of profitability still impose seasonality (Cook and Calvin, 2005).

Competiveness of the Mexican tomato on the US domestic market increases with technology and product diversification for the two leading tomato producer/export regions (Sinaloa and Baja California). Protected horticulture is a major new force, influencing both export and domestic markets (both are important for the profitability of grower-exporters). The development of protected horticulture throughout Mexico, is bringing new tomato products into the domestic market, competing both with traditional small open-field producers in central Mexico and growers in Sinaloa and Baja in their seasons.

In the United States, the largest greenhouse areas are located in the States of Arizona, Texas, Colorado and California. These firms grow tomatoes year-round, and represent 67% of all American greenhouse production.

Final domestic consumption figure largely depends on tomato exports to the United States, as it is basically a residual after exports (Flores and Ford, 2010). Tomato consumption is price sensitive in Mexico, thus marginal changes in prices tend to lead to significant changes in demand. Contrary to 2009, traders indicated that the tomato exports increased from January to March 2010, resulting in higher domestic prices as demand from the international market was strong.

Table 28. North American Fresh tomato industry a comparative of open field and greenhouse crops, 2004 (Source FIRA, 2007 (adapted from Cook and Calvin for 2004)).

	Unit	USA	Canada	Mexico	North America
Greenhouse tomato production	Metric tons	167,896	216,862	160,000	544,758
Greenhouse area	Has.	350	446	1,000	1,796
Average greenhouse yield	MT / ha.	480	487	160	376
Fresh field tomato production	Metric tons	1,739,300	26,882	1,967,800	3,733,982
Fresh field area	Has.	50,304	1,813	63,300	115,417
Average open field yield	MT / ha.	35	15	31	27
Percentage of greenhouse tomatoes, per country	%	9	89	8	12
Estimate of greenhouse import 2,3	Metric tons		130,154	125,970	256,124
1 Excludes area and production of processed tomatoes in the three countries					
2 The official figure of the US Department of Commerce for greenhouse tomatoes imported from Mexico is different. The figure here includes an estimate of tomatoes imported from Mexico with a wrong tariff. 3 Tomato imports originating from outside North America totalled 24,093 metric tons					

Local tomato prices tend to rise from March to May because of increased exports from the state of Sinaloa, which in turn reduces supply in the domestic market. Exports also increase from June to August, as this is Baja California's international market window. By the end of November and December, tomato prices usually rise again, due to an increased rate of exports from the states of Jalisco and Sinaloa. The tomato paste industry always buys tomatoes from the fresh market in addition to buying contracted tomatoes for processing. However, price competition in the fresh market has developed into a real problem for the processing industry. Over the past several years, relatively high fresh tomato prices have diverted product away from the processed market (Flores and Ford, 2010).

4.3 Canadian market

Some figures on Canadian greenhouse production for 2010 are given in Table 29 (used technology) and Table 30 (production volume and value). The trend is for rigid plastic to be substituted by glass and poly-film. Total area of protected horticulture has not increased from 2009 to 2010.

Table 29. Canadian greenhouse production, all crops.

	Total greenhouse units	Total greenhouse area (has.)			
		Total	Glass	Rigid plastic 1	Poly-film
2009	3,335	2,236	755	149	1,332
	% of total area	100%	34%	7%	60%
2010	3,285	2,286	779	114	1,393
	% of total area	100%	34%	5%	61%
	growth in area	2%	3%	-23%	5%
1 Includes all other types of enclosed protection used for growing plants, such as rigid insulation, mine shafts, barns and shelters.					
Note(s): Includes greenhouse vegetables and greenhouse flowers.					
Source: Statistics Canada, 2011					

Table 30. Canadian greenhouse production, main crops.

				Production	Farm gate value	Value / kg
				Metric tons	(Can. Dollars)	
Tomatoes	2009		4,952,311	242,547	458,681,260	1.89
	2010		5,281,682	260,407	508,865,120	1.95
		% growth	7%	7%	11%	
Pepper	2009		3,537,868	87,538	235,161,600	2.69
	2010		3,787,568	92,533	270,123,295	2.92
		% growth	7%	6%	15%	
				in dozens		Value per dozen
Cucumber	2009		3,281,416	39,380	246,484,705	6.26
	2010		3,483,329	49,344	254,077,090	5.15
		% growth	6%	25%	3%	
Note: on December 31, 2010, the exchange rate Canandian dollar – US dollar was close to 1, namely 1 CAD = 0.99977 USD						
Source: Statistics Canada, 2011						

Canada is Mexico's main competitor on the fresh fruits and vegetables market of the United States. Sales of Canadian greenhouse fruits and vegetables increased by 10% from 2009 to 2010, to surpass the $1 billion mark in Canadian dollars. The bulk of fruit and vegetables production is produced in the state of Ontario, representing 60.9% of total sales of greenhouse fruits and vegetables in Canada. Tomato sales increased 10.9% (16.1% in British Columbia). Greenhouse lettuce was mainly produced in Quebec.

As for benchmarking greenhouse production: for specialized fruit and vegetable producers, electricity expenses increased by 12.7% from 2009 to 2010; labour costs represent almost one-quarter of the total operating expenses; the average cost per employee is $21,580 compared to $14,412 for specialized flower and plant greenhouses (Statistics Canada, 2010). Specialized vegetable greenhouses are in operation during a longer period of time and are hiring a larger proportion of permanent employees.

4.4 Competitiveness of Mexican protected horticulture

Key indicators for competitiveness in Mexican protected horticulture varies considerably among enterprises. In terms of labour costs labour intensity in Mexico is higher than in either Canada or United states, but decreasing in protected horticulture, as labour efficiency is improving. In a sample of four enterprises producing fresh tomato with high technology, labour costs oscillated between 10.5 and 36.2% of total production costs. Nevertheless, labour costs of enterprises with medium technology varied between 22 and 38% of total costs; and between 36 and 50% for enterprises with low technology (FIRA, 2010) See annex 2. Protected horticulture will thus slow labour demand in the Mexican vegetable sector, which will depend more on consumption trends in the domestic market.

Revenues for enterprises applying high technology may vary considerably. In the case studies presented by FIRA (2010), production costs in protected horticulture in 2006-2007, varied among the sampled enterprises (19 in total). In general. 60 to 75% of all variable costs consist of labour, packaging, transport, marketing and fertilizers, representing the areas in which competitiveness can be improved. According to FIRA the return on assets is determined by:

- Sufficient operation scale: enough volume enables direct marketing of whole containers to the market at improved export prices without the need to pay for commission to intermediary exporters;
- Ratio between investments made in infrastructure (irrigation, heating, packing), against achieved yield and sales prices. Management capacity (internal or hired) to optimize the use of climate technology and crop specific agronomist practices;
- Marketing experience and an already developed market position, preferably in a differentiated market segment (tomato on the vine, organic cherry etc.)
- Compliance with food safety certification for export and Good Agricultural Practices (GAP).

According to FIRA, the following factors play a major role in the competitiveness of Mexican protected horticulture in comparison with the United States and Canada:

- Demand: capacity to fulfil demand for products that guarantee compliance with food safety, traceability, prolonged shelf life and in different presentations.
- Localization of Mexican protected horticulture in most suitable climatological regions considering the use of energy (fuel, electricity, water) needed for climate control
- Market: appropriate knowledge on size of market segment, localization, prices and seasonality of the demand for products to be produced under protection, enabling informed decision making,
- After having established market characteristics, design of appropriate production and postharvest technology, according to distance to market and purchasing power of consumer
- Sufficient scale: 6 to 12 hectares for export and 1.5 hectares or more for domestic market.

4.5 The domestic vegetable supply chain

About 26% of Mexico's production of fresh produce is exported (v. 15% pre-NAFTA). This means that most production is still for domestic use. Hence, employment and revenue in the Mexican horticultural sector is first dependent on trends in Mexican consumption (110 million inhabitants); then on U.S. demand.

Fresh tomatoes destined for domestic consumption, including imported tomatoes, pass through various wholesale markets throughout Mexico and proceed to large supermarkets and retail stores. A few stores import directly without going through the wholesale market channels, but this is still somewhat rare since most retail operations do not have import expertise.

The vegetable supply chain is characterized by a fragmentation and numerous links of intermediaries. This makes the supply chain less transparent and traceable.

It is estimated that approximately 45 per cent of food sales now take place in the formal retail sector, placing the total retail food market at over US$120 billion (others estimate $121-$124 billion) (Cook, 2011). The number of modern food retailing stores is estimated to have reached 10,473, just over double the 5,055 stores in 2002. Much of the growth came from convenience stores, up from 3,000 in 2002 to around 7,400 in 2009.

These trends support the change towards protected horticulture; as quality requirement are becoming more strict. This will have some further implications for the vegetable supply chain, such as:

- Direct sales from grower-shippers to retail chains, bypassing wholesale markets, and higher quality standards.
- Continuous supply of quality volume and consistent / homogeneous quality in colour and size
- Small and continuous deliveries throughout the year
- Washed, waxed and packet product and delivered in carton boxes
- Product defect tolerance rate of 10%
- Transport with controlled temperature.
- Payment period between 8 and 45 days after delivery of product.
- Market conform prices

This benefits the large export-oriented grower-shippers – who are facing the same trends in the U.S. and already meet the requirements (Cook, 2010; Sagarpa 2011). Their share on the Mexican market may increase.

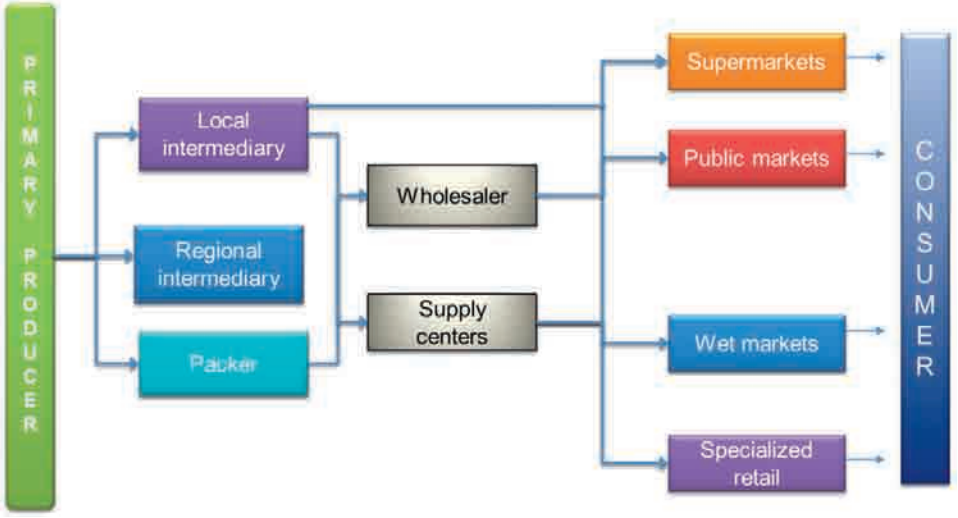


Figure 17. Flow chart of the national Mexican vegetable supply chain (Source Eduardo Espinoza, SAGARPA, 2010).

4.6 USA retail sector

Fresh produce items are consumer-ready products, directly impacted by food marketing trends. Large retail and foodservice buyers demand year-round supply, increasingly provided by U.S. grower-shippers which import during the off-season, including from Mexico. Large Mexican growers that export (grower-exporters) have generally not been able to put together year-round deals themselves (Cook, 2011). The 23 largest U.S. grocery buyers now control around 72% of U.S. grocery sales. The importance of procurement practices and marketing services is increasing. Scale is increasingly important to compete. California firms (suppliers-shippers) dominate, followed by Florida and Washington.

The trend is towards vertical integration to better match demand and supply and improve market transparency. Suppliers and buyers (retail or foodservice) partner together to gain logistical and operational efficiencies as well as consumer insights. Regardless of the special challenges of produce, fresh produce is increasingly being asked to conform to the standards of the consumer packaged goods (CPG) industry.

Food safety standards for export-oriented producers are essentially the same as in the U.S. since they must be 3rd party certified (just as U.S. growers). This is not the case for producers oriented to the domestic market. Food safety programs require significant investments and are a barrier to entry.

Export requirements are defined by importing (north American) brokers and retail chains:

- Year round supply of consistent quality according to USDA classification (class 1, 2 etc.)
- Detailed traceability
- Implementation of food safety measures.
- Broker requirement in size, colour, weight, ripeness, packaging (carton boxes)

Mexican exporters will have to meet these requirements. Year-round supply can only be realized by large, well-organized growers, or by groups of growers. Traceability requires a high level of management of the supply chain and farm activities, supported by adequate technology and knowledge. Food safety in the first place means low application rates of chemicals and good past-harvest cooling and transport facilities. Grading is a technical issue, which, however, may require considerable investments.

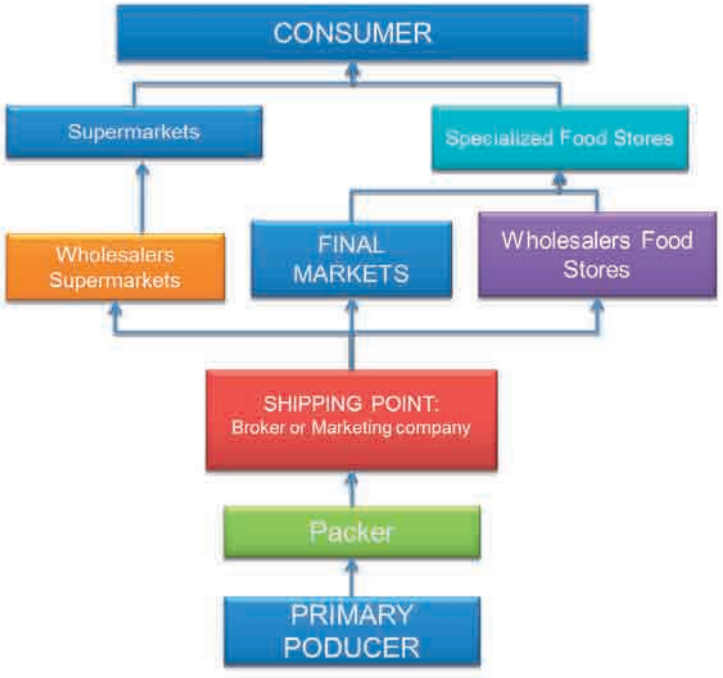


Figure 18. Flow chart of the USA vegetable supply chain.

4.7 Market of ornamentals

4.7.1 Domestic flower supply chains in Mexico

Most floriculture production is traded through the wholesale market (Central de Abastos, 55%) and the flower market (Jamaica, 10%) in Mexico-City. Only 15% is distributed through wholesalers. The internal market for ornamentals is severely restricted by a lack of space in Mexico City's wholesale market; the resulting congestion results in about 20% of all the fresh flowers arriving daily at the market having to be destroyed.

It is estimated that 95% of flower products is sold through traditional outlets and 5% through retailers. Retailers do not obtain flower products through central distribution, and the largest national chains are almost exclusively serviced by the larger growers (de Rijk, 2008).

4.7.1.1 Cut flowers

Most of the production of cut flowers is directed to the domestic Mexican market. The Mexicans consume flowers at special occasions. However, according to an interviewed florist, the market is mainly supply-driven. Quality and continuity of supply are not as stable as the retail sector would.

The Central Wholesale Market of Mexico-City (Central de Abastos) is the main wholesale market for cut flowers. Other local wholesale markets are active, like Tenancingo or Villa Guerrero in Mexico State.

A sector study by the Office of the Agricultural Counsellor of The Netherlands in Mexico (De Rijk, 2007) indicated that the main way to distribute the flowers is through intermediaries that buy the flowers from a series of small producers and sell them at local wholesale markets or the main flower market at the Central de Abastos.

At the wholesale markets cut flowers are re-sold to other intermediaries, wholesalers from all over the nation and local retailers. The distribution circumstances in the chain can not guarantee a minimum quality level, some bigger professional growers excepted. This leads to a generally poor quality in flower shops. Loss of products in the supply chain is too high, compared to international acknowledged standards.

The sector study points out a new development: the grouping of individual growers that coöperate in the marketing of the flowers throughout Mexico, and forecasted that the domestic market would remain strong due to the increasing living standards in Mexico, although the absence of generally accepted quality standards would reinforce this market.

4.7.1.2 Potted plants and the "concentradoras"

Ornamentals are produced almost exclusively to satisfy a growing national demand. Commercialization is mainly through general perishable wholesale markets, in Spanish named "mercados de Abastos" or through "concentradoras", companies that concentrate the supply under one roof (see**Error! Reference source not found.**). Only a few growers export cut flowers, and the export share does not seem to increase.

In the potted plants industry the producers are more focused on coöperation in marketing than flower growers. The distribution structure is more transparent. An example of these efforts is to be found in the state of Morelos, where groups of growers organize in "concentradoras", cash & carry-like wholesale markets were producers sell their products to wholesalers, retailers (garden centres) and public in general. The first and biggest of this "concentradoras" is CONAPLOR (Concentradora Nacional de Planta Ornamental), in Cuautla. 83 members own this trade organization (they all brought initial capital, the installations and the soil, an extension of 8 ha, were heavily subsidized) and concentrate the ornamental plants produced in 200 ha.

To this example, many smaller "concentradoras" are flourishing in the whole of the State of Morelos. The "concentradora" does not become owner of the produce, but facilitate services in sales, credits, capacitation, centralized purchase of inputs, tools and workforce, cold storage, docks for load / unload of trucks. Members own a physical space for placing their products and determine their own selling price, which leads to an organization which is totally supply-oriented instead of buyer or customer-oriented. So the same products are offered in physically different places at different prices. The produce, presentation, size, quality, is unstandardized; there are no quality rules, as there is a market for each quality and price offered. Members are neither obliged to commercialize through the organization: if they can get a better price outside the commercializing system they do it. Their ambition is to reach the international market, but to export they need to standardize. (This is something they do not seem to be aware of).

A great limitation for plant export is the fact that soil can not be exported, so experimenting with new root media is a serious necessity to impulse the sector to export.

4.7.2 United States flower market

Market leaders in the US cut flower industry are Colombia (65% market share) and Ecuador (16%). According to figures from the National Statistics Administrative Department (DANE), Colombia exported for an amount of USD 753.6 million of cut flowers in the first half year of 2011. This figure gained 22.8% compared to the figure for the same period of 2010. The value of the export of roses in the first half year of 2011 was USD 237.2 million, carnation amounted for USD 42.7 million, pompoms for USD 45.7 million and alstroemeria for USD 34.3 million.

Table 31. Imports of prepared cut flowers and buds for bouquets etc. (code HS0603) (in thousands $ USD).

	2005	%	2006	%	2007	%	2008	%	2009	%	2010	%
World	708,949		768,112		831,503		803,648		767,690		846,973	
Colombia	418,318	59	448,581	58	507,699	61	501,555	62	506,765	66	548,417	65
Ecuador	129,283	18	141,407	18	145,183	17	134,073	17	118,371	15	136,912	16
Netherlands	64,726	9	72,573	9	69,211	8	60,183	7	47,590	6	49,631	6
Canada	17,750	3	14,282	2	16,174	2	20,930	3	20,712	3	35,003	4
Mexico	19,844	3	21,603	3	23,059	3	23,956	3	21,331	3	22,356	3
Costa Rica	23,429	3	29,865	4	30,975	4	28,197	4	23,068	3	19,998	2
Thailand	4,815	1	6,988	1	7,426	1	7,771	1	7,047	1	8,410	1
Guatemala	3,888	1	4,048	1	3,864	0	4,289	1	4,484	1	4,799	1
Peru	2,286	0	3,826	0	2,785	0	2,381	0	2,086	0	4,197	0
New Zealand	4,627	1	5,284	1	5,706	1	3,961		2,936	0	2,669	0
Source: Foreign Trade Division, U.S. Census Bureau, 2011												

In the last six years, Canada strengthened its importing position to the cost of the Netherlands and Costa Rica. Peru, an insignificant trading partners for the US flower market, doubled its exports of flowers from 2009 to 2010. The value of exported flowers from Mexico has been stable in the last 6 years. Mexico has a strong competition position in relation to natural conditions and transport costs as well as production costs; but scores poorly in terms of quality, reliability, credit costs, network and government support.

The biggest challenge for Mexican producers is to get their product across the border fresh and undamaged. As few as 150 flower growers (carnations and roses) possess high-tech greenhouses and are equipped to produce export quality flowers. In 2010, flower growers in the Mexican state of Baja California exported 8 million dollars' worth of flowers to the United States, mainly to the bordering state of California. This makes Baja California the only Mexican federation state to export almost its entire floriculture production.

4.7.2.1 Cut flowers supply chains in the United States

The supply chains in the United States are slightly different from those in the European Union. Main difference is the absence of the strong auction. Furthermore the importance of mail services and internet for the purchase and delivery of flowers is larger, because of the larger distances in the country.

The market channels that can be distinguished in wholesale business are as follows: (Flower Council Holland, 2007).

- The importing company buying from its own production company in South America (besides optionally importing flowers from other South American companies). Some of these importing companies have established their bouquet assembling companies.
- The agents and brokers. They do not own production companies, but import and sell to the national wholesale business only.
- Wholesale companies that also import, besides buying national production or from importing agents. These usually have 4 to 15 branches, each with its own purchasing policy. Their clients are florists and supermarket chains.
- National wholesale companies that do not have the scale to import directly. They buy from producers or importing agents / brokers.
- National production companies selling to wholesale and retail.

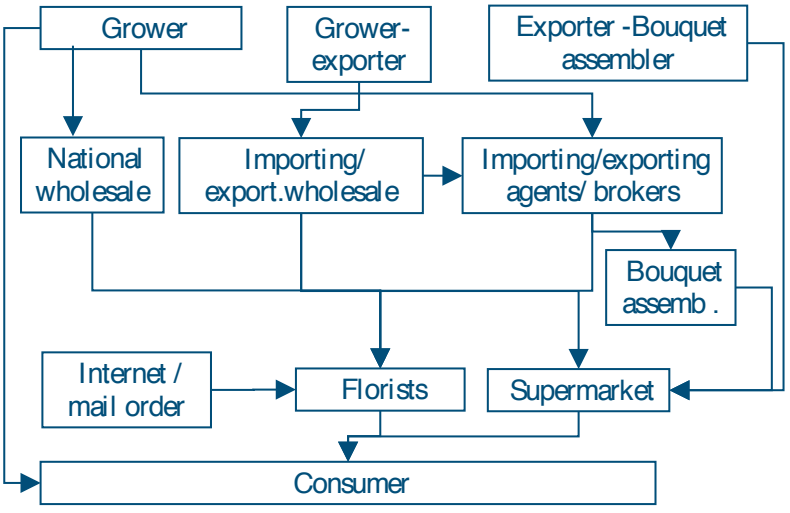


Figure 19. Cut flower supply chain in the USA (Source van de Valk, 2007).

4.7.2.2 Domestic wholesale in the United States

The total wholesale value of floriculture crops sold by operations with $100,000 or more of sales in the 15-State program is $3.98 billion for 2010, up 3% from the revised 2009 total. These operations account for 96 percent of the total value of $4.13 billion in floriculture crops, but comprise only 44% of all producers. California accounted for 25% of the total wholesale value in the 15 States. Florida ranks second with 20%; while Michigan, Texas, and North Carolina round out the top 5 States accounting for 10%, 7%, and 6% of the total, respectively.

The traditional importers have always had a strong market position. They decide who will deliver / supply, and thus also the assortment that is available to the retail and the consumer. Importers are very interested in year-round products with a sharp price, like carnation, roses and chrysanthemums (the bulk products). There is less interest in exclusive products that are only available through a small number of suppliers and only during a part of the year. Exclusive products are bought when there is demand from the retail. (Flower Council Holland, 2007).

Due to integrated supply chains and direct import by supermarkets, as well as internet business-to-business internet companies, the strong market position of the wholesale is decreasing, giving room for a broader assortment for retail and consumer.

4.7.3 USA domestic floriculture production9

California and Florida are the leading floriculture production states. These two States account for 44% of the total value from the main 15 floriculture States. For 2010, the top 5 States are California, Florida, Michigan, Texas, and North Carolina. Together they account for $2.75 billion, or 66 percent, of the 15-State total value.

In 2010 there were 6,126 floriculture producers (), covering a total areas for floriculture crop production of 725 million square feet (approximately 6,733 hectares). Approximately half of the covered area (56%) is permanent, the other half (44%) consisting of shade houses and temporary cover. See Table 32.

The states of California and Ohio have the largest share of glass greenhouses (25 and 15% respectively); while 80% of all shade houses and temporary cover is found in Florida.

Table 32. Floriculture crops summary for the USA.

	Area (ha)	Fraction of total
No producers	6,126	
Glass Greenhouses	538	8%
Fiberglass and Other Rigid Greenhouses	636	9%
Film Plastic (Single / Multi) Greenhouses	2,584	38%
Total Greenhouse Cover	3,758	56%
Shade and Temporary Cover	2,975	44%
Total covered area	6,733	100%
Open ground	316	
Source: Floriculture Crops Summary April 2011 * For operations with $10,000+ sales		

4.7.3.1 New opportunities for the ornamental market

New opportunities arise for the sector as young plant producer for other Latin-American countries that need growers for their unfinished, export ornamentals. Young plants could be grown in Mexico to a certain size, exported to Latin American growers that will grow then bigger before exporting them to the US. For this market, also the producer needs to commit and supply as planned; as a damaged reputation is never recovered.

9 Includes bedding and garden plants, but no nurseries

5 Expansion of Mexican horticulture

To determine the market opportunities of the Dutch supply industry, it is helpful to assess the future changes in protected cultivation in Mexico. Change can come in many ways:

- acreage
- production
- quality
- crops
- greenhouse construction
- greenhouse installation
- management

Returning to the issue of technology level (see 3.5), an increase in acreage can take place if for example land is cheap relative to investments in greenhouse construction of installation, and easy to obtain relative to investments in knowledge. Low-tech farms may remain low-tech, while medium-tech farms may gradually change to high-tech farms, adapting certain modules.

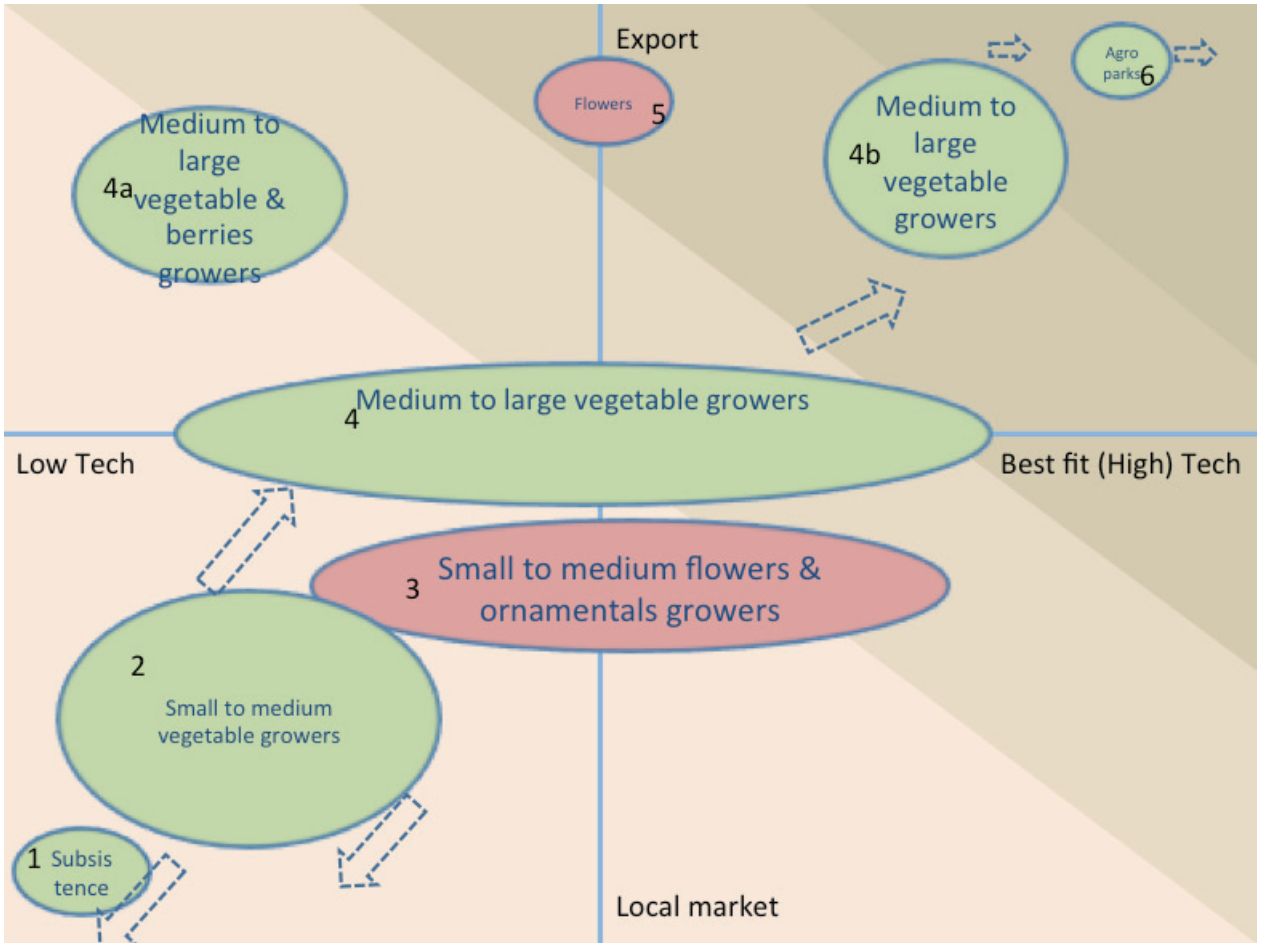


Figure 20. Technology development trends for protected horticulture in Mexico. See text for explanation of 1-6. The size of the oval represents the approximate size of the segment. The arrow gives the assumed development direction of the farm segment. The darker the background colour, the more market opportunities to be found for Dutch input suppliers. Red ovals flowers; green ovals vegetables.

Figure 20 gives a schematic representation of the variety of horticulture farm types that are found in Mexico. The x-axis distinguishes farms on the basis of their technology level, and the y-axis does this on the basis of their market orientation. The y axis moves from local (municipality) oriented to state market, national market and export market. On the whole, farm types move from low-tech farms that produce for the domestic market towards high-tech farms that produce for the export market, but this cannot be considered as development path for all farms. Technological levels and markets sometimes coexist in the same, bigger companies, depending on the achieved produce quality. In general, export orientated farms tend to have a larger size. In this sense, it is important to note the high level of the fragmentation of Mexican farms: a small sized farm will have no more than 1 ha; while most medium sized farm will measure 1 to 3 has. A large farm measures more than 10 ha.

1. Subsistence farms: small scale (up to 0.5 ha) farms that have set up small (plastic) greenhouse constructions as promoted and subsidies by SAGARPA. They sell to local markets. This segment is very susceptible to abandoning and very unlikely to invest in further technology improvement, so not interesting for market development by Dutch industry.
2. Small to medium scale (0.5 to 2 ha) commercial farms that have formed clusters for commercialization of their produce. Their investments are (co-)financed by governments subsidies and soft loans from SAGARPA and FIRA. Collectivization of input supply; collective marketing is mainly farm driven, that is, produce is jointly offered, but varies in quality and is sold per individual farm. They target domestic bulk markets. Potential investments will occur when farmers target higher value markets, moving towards medium technology to improve quality and diminish climatologic risks. Investments depend on their ability to develop proper marketing structures. The farms failing to develop a market position will stagnate and de-invest. This is valid for both vegetable and flower growers.

   Binding conditions for further development for this group depend heavily on their capacity to organize for the market, develop distribution / marketing channels and standardize quality. Dutch experiences in organizing farmers for the market, e.g., through auctions, gives Dutch industry a comparative and marketable advantage.
3. In the case of flowers and ornamentals, small to medium scale farms can be found in the central states of Mexico (with geographical focus on Villa Guerrero (Morelos), supplying to the wholesale market (Central de Abastos) in Mexico-City. Left from the y-axis is represented the area of Morelos; to the right the area around Mexico (Tenancingo). Part of this segment can be expected to change from open field production towards the use shade or greenhouses with low to medium technology. As the consumer in the domestic markets is not very quality conscious, incentives for strong technology improvements are lacking, but the need for good varieties offers opportunities for the young plant suppliers.
4. This sector of medium to large (5 to 10 ha) vegetable growers knows two regions: the central and western states of Jalisco and Michoacán, and the northern states of Sonora and Sinaloa.
    - Farms are developing in Jalisco and Michoacán (left part of the oval). They currently produce mainly for domestic markets but have the potential to engage in export markets. Depending on current market position and network, and because of the size of the segment, they represent the main potential for technology development.
    - In Sonora and Sinaloa (this last one with a clear technological evolution), enterprises have an already established track record in exporting. These farms are renovating and innovating to uphold product price with continuance of quality and quantity. In vegetables, these farms are looking for product innovation with added value for specific retail niche markets in the United States and Canada. They expect technology input suppliers to support them in finding the right product-market combination with best-fit technology.

There are two other groups of medium to large growers:

4a. Vegetable growers in Baja California North and South and in Sonora - Sinaloa with a low level of technology (in which they differ from the above-mentioned group) but a good exporting record, but due to low productions not susceptible to generate investment capacity for new technologies but rather in good quality seed and plant material. Growers in niche markets, like berries, belong to this oval too, but are successful and might be susceptible for investment in yield and sustainability increasing technology.

4b. Export oriented, newly established growers in the states of Durango, Chihuahua, Coahuila, San Luis Potosí, and Nuevo León, with medium to high level of technology and probably an interesting market for technological upgrade by the Dutch supply industry. The market situation is to the level of state to national with some export oriented areas

Medium to large vegetable growers are a very attractive group for Dutch involvement. A tailor-made approach that focuses on relevant modules of greenhouse horticulture can help them advance. Critical mass and production level and commercial links are the most important binding conditions. Clustering is required for feasible integration into market chain and investments in packing lines and other postharvest facilities. Farm technology development will be product-specific, aiming at quality standardization / continuity for bulk market. The more advanced farms with strong export position look for support in developing an integrated farm concept directed at servicing a specific market with a specific added value product.

5. In cut flowers, medium to large scale farms are found in Baja California exporting to the Californian market. Development demands unknown. This group is of interest to Dutch industry, and is best assisted in an integrated approach.
6. Agroparks. Large agro-industries (> 10 ha) that operate in integrated market chains focussing on the export market, mainly the United States and Canada. They operate with commercial loans and equity capital (*e.g.* FIRA, FOCIR). FOCIR promotes the clustering of high tech enterprises in agro-parks. Technological development is likely to focus on more efficient use of renewable and non-renewable resources. Interesting for Dutch industry for development of integrated concepts requiring innovative and higher investments. Dutch involvement must be through an integrated approach.

In the paragraphs below some estimates of future growth are given, mostly in terms of acreage / production. It is extremely difficult to forecast changes in technology level. We believe that here lies an important major role for The Netherlands: help defining, prioritizing and shaping with the Mexican horticultural sector its options for change.

5.1 Projected expansion and technological up-scaling

5.1.1 Historic information

If the acreages of Table 16 and Table 17 are added, then a total of 14,183 ha of protected cultivation is reached. This might be an under-estimate, as the acreages given in Table 15 are higher. A figure that was developed by the Netherlands Embassy reported an acreage of 8708 ha in 2007, coming from 50 ha in 1995 (Figure 21). Table 20 gives a total of 11,759 ha in 2010. The exact figure is therefore very difficult to establish, and can for 2010 vary between 12,000 and 20,000 ha.

More important, however, is that all data show a strong increase in acreage over the years. Over the last 10 years, approximately 1,000 ha or more has been added annually.

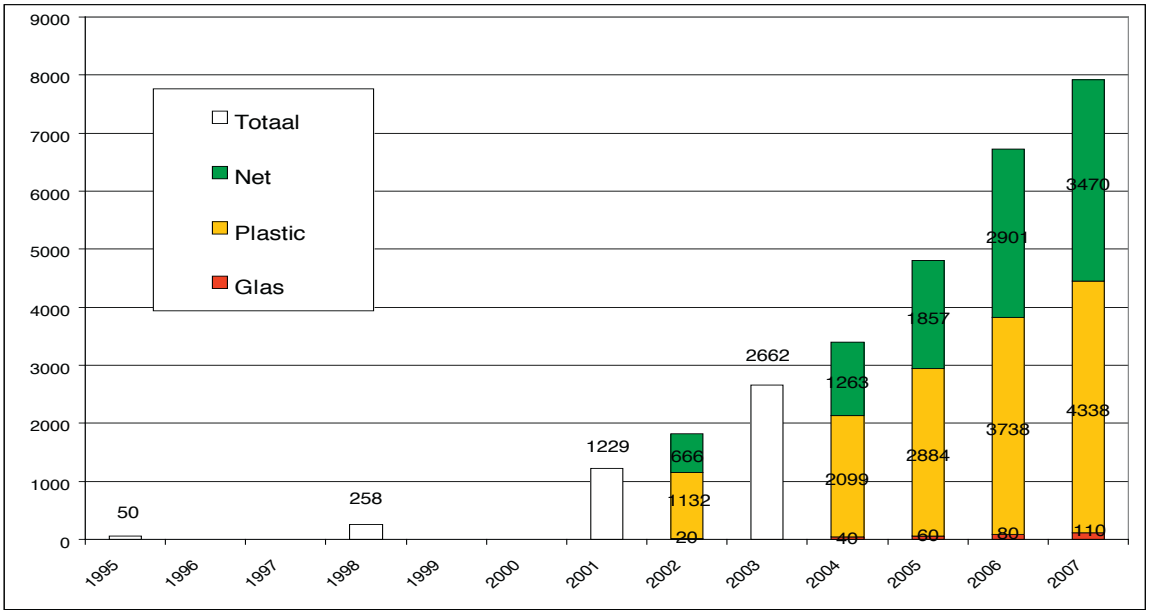


Figure 21. Historic acreage estimates (source Netherlands Embassy).

5.1.2 Forecasts

The AMPHAC 2009 survey included questions on future (2-4 years) plans for expansion and technological up-scaling, as well as the requirements to achieve this expansion (Table 33). A quarter of the Sonora growers see implementation of a higher technology level as their main priority. Farms in Baja California Sur are economically weak and indicate to be very dependent on subsidies and credits to implement higher levels of technology.

From the companies interviewed by the Office of the Agricultural Counsellor of The Netherlands in Mexico between 2007 and 2010, a few indicated their expansion plans.

In Baja California, expansion by companies larger than 10 ha would imply 135 ha of net houses. An expansion of 10-15 ha of plastic medium technology greenhouses is planned in Sonora and Zacatecas, and 100 ha in Durango.

The largest growth in acreage is planned by Sinaloa companies of more than 10 ha. Their joint projected an expansion is 500 ha of protected horticulture, however, of which 95% concerns low technology (plastic / net houses). It is not clear how much of this expansion has already been achieved, but the severe (and unusual) frost period of February 2011 that caused severe losses, might have changed the expansion focus of the companies to a more "any climate" type of greenhouse structure.

In Querétaro, at least 45 ha expansion are projected for 2010 and 2011 (informal sources). Other Agroparks are planned for the states of Aguascalientes and Morelos.

Table 33. Projected expansion per State (source AMHPAC 2009). Note % is fraction of the enterprises providing data, not % of acreage!

		Sonora	Sinaloa	Baja California	Baja California Sur
	participating acreage	1200 ha	3272 ha	2878 ha	200 ha
Expansion plans	% Expand/ upscale	53%	80%	93%	100%
	Shadow house	25%	40%	80%	100%
	Greenhouse	15%	60%	60%	27%
	Cold store	6%	20%	53%	75%
	Machinery	6%		53%	62%
	Packing equipment	6%		53%	100%
Requirements for expansion	Technical Training/assistance		50%	39%	
	Management training / assistance		50%	22%	
	Financial training/ assistance			39%	

Table 33 suggests that, as a rough figure, over the coming 4 years a 50% increase is at least planned in some of the most important states. If we assume that only half of the plans are realized, then we reach to approximately a 5% increase per year; applying this to the current acreage of 12,000 to 20,000 ha (average 16,000 ha) results in approximately 800 ha increase per year. This is roughly the same figure as has been realized over the last decade.

Of course, this are only rough estimates, but it is clear that Mexican protected horticulture should offer substantial possibilities for Dutch supply industry.

5.1.2.1 Market opportunities

Table 33 gives the products and services needed to supply the expansion are chances for Dutch suppliers:

- Management training / assistance
- Financial training / assistance
- Cold stores and packing equipment

Useful technology for the Mexican market comprises:

- Glass cover only for Agroparks (unless new developments in diffuse glass covers that have shown production increases of nearly 10% are well promoted)
- New generation foils and netting
- Good fertigation systems that are simple to operate.
- Sensor technology: pH, EC, temperature, RH, CO_2, radiation, drain, etc.
- Simple measurement equipment (pH, EC and quick analysis kits)
- Biological pest management, scouting systems
- Good, compatible pesticides.
- Safe and reliable spraying equipment
- Recirculation and disinfection technology.
- Cooling facilities
- Harvesting, grading, packaging systems
- Seed and planting material (especially if export increases)
- Knowledge in all forms and at all levels.

We see less possibilities in

- CO_2 supply technology: closed greenhouses are not likely.
- Substrates, as local products as tezontle and agrolite are gaining popularity

If complete greenhouses for the expansion plans of the agroparks in Queretaro and elsewhere are realized, then this offers ample opportunities.

6 Summary and discussion

The purposes of the project were to provide:

- a detailed, accurate and actual description of the Mexican horticultural sector and its sub-sectors, in terms of crops (vegetables, flowers, bulbs, plants), acreages, production, production system, technological level, innovations, sustainability, market situation, etc.
- an analysis of the technological level that is suitable for specific production and market systems and a view on expected technological developments.
- A SWOT analysis of the Dutch supply industry and export competitiveness, also in comparison to other suppliers to the high and medium-tech Mexican horticultural sector.

A SWOT analysis has recently been made by the Dutch supply sector, and is reproduced in Annex III. We present our SWOT analysis in a discussion form in paragraphs 6.4 and 6.5.

6.1 Data quality

The lack of out-dated, incomplete and not always reliable data on the Mexican greenhouse horticultural sector, and therefore the difficulties in taking commercial decisions, motivated this study. A wide range of literature sources was consulted, and a series of key persons was met during a mission to Mexico. This was followed up with further requests for information, which was in many cases supplied. We therefore believe that we have accessed a wide and valid sample of the available information, without conducting direct inquiries with growers themselves (which would have been an enormous task). For sure, we will have missed bits and pieces, but we would be surprised if these would seriously alter the findings of this study.

We consider the information gathered in this study as recent as can possibly be collected in such an assignment. Data are still not complete, which is associated with the issue of reliability. By comparing and combining information from various sources we have tried to establish a picture as complete and reliable as possible. Data should however be dealt with carefully, and in many instances be treated in a more qualitative way than in a 100% quantitative way.

The greenhouse horticulture sector would benefit from a better registration system, certainly for the medium and high-tech farms.

6.2 Regions and crops

Greenhouse horticulture is wide-spread over Mexico, and knows a wide diversity of crops. 60% of the acreage is concentrated in 5 states, viz. Sinaloa, Baja California, Baja California Sur, Jalisco and Mexico. Strongest growth is taking place in Sinaloa, Jalisco, Guanajuato and Michoacán. Queretaro is important for its agropark. Tomato is by far the most important horticultural crop, to which 50% of the acreage is allocated. Cucumber, peppers, and eggplants follow. Berries are gaining importance. Mexico and Morelos are the most important states for the production of flowers, while production of potted plants is wide-spread over the country.

6.3 The international market

Relevant for the development of the vegetable sector is the export to the USA, and to some extent Canada. Mexico can compete on the basis of increased consumption in the USA and Canada and timing of production. Good logistics, quality and traceability are essential, as is cost reduction. Cooperation in the sector will be increasingly important in the future to remain competitive.

The ornamental sector will largely depend on the domestic situation. It is not feasible to compete with other Latin America countries in the field of cut flowers. Their quality and logistics is superior. It will require very large steps to develop an industry-type of ornamental industry that can compete internationally. Hardware, knowledge, infrastructure, cooperation are just some of the issues.

The Netherlands can assist in many of these issues. The Netherlands has wide experience in setting up production facilities, farmer and sector organization, marketing, post-harvest management, and many other issues. The question, however, is whether the Mexican sector is willing to invest in this involvement.

6.4 Technology levels and transition processes

The stratification of technology levels in low, medium and high is often used in the Mexican context (and in other contexts, for that matter). The advantage is that at first glance, communication and understanding are simplified. It carries some serious dangers, however. The two most important ones are:

- Definitions vary which causes unreliable analysis and decision making.
- It ignores complex transition processes that work more at the level of modules than entire systems.

Both aspects can negatively affect issues such as the detail of the analysis, prioritization, decision making, and design of future systems. For example, a greenhouse owner will normally not move from medium to high-tech in one large step, but successively up-grade components of his greenhouse. It is important then to maintain the balance of the components. For example, a new fertigation system is used best if also the level of knowledge is increased and if marketing opportunities for a product of higher quality have been linked with. Only large investors may choose to construct a high-tech greenhouse.

These processes are probably well-understood by most entrepreneurs in the horticultural supply industry, but may prove a hurdle for cooperation in a competitive market.

The Dutch horticultural industry is world-leading in supply of all components. Constructions, installations, knowledge, logistics, organization structures are some of the Dutch competences. Given the fact that horticulture in The Netherlands is state-of-the-art, The Netherlands supplies high-quality products and services. Therefore, the obvious markets for Dutch suppliers in Mexico is formed by the medium and high-tech sectors, which comprise a mixture of medium and high-tech components. With Dutch involvement, medium-tech components can be replaced by more-high-tech components, and high-tech components can be replaced with higher-tech components.

The low-tech sector is of much less interest to the commercial supply sector, although Dutch knowledge on cultivation, organization and also logistics would be very useful.

A stratification is presented in Figure 20. If everything is put together, we conclude that the following is of most interest to Dutch industry:

1. Small to medium scale (0.5 to 2 ha) vegetable farms that have formed clusters for commercialization of their produce. Dutch experiences in organizing farmers for the market, e.g., through auctions, gives Dutch industry a comparative and marketable advantage
2. Small to medium scale flower and ornamental farms can be found in the central states of Mexico and Morelos. Incentives for strong technology improvements are lacking, but the need for good varieties offers opportunities for suppliers of young plants.
3. Medium to large vegetable growers are a very attractive group for Dutch involvement. A tailor-made approach that focuses on relevant modules of greenhouse horticulture can help them advance. Vegetable farms are developing in Central and Western States of Mexico (Jalisco, Michoacán), mainly producing for domestic markets but with the potential to engage in export markets. Depending on current market position and network, and because of the size of the segment, they represent the main potential for technology development. Vegetable farms in the northern states of Mexico (Sonora, Sinaloa) have an already established track record in exporting and are further innovating. They expect technology input suppliers to support them in finding the right product-market combination with best-fit technology. Vegetable growers in Baja California North and South and in Sonora-Sinaloa have a low level of technology but a good exporting record, and require good quality seed and plant material. Newly established vegetable farms in Durango, Chihuahua, Coahuila, San Luis Potosí, and Nuevo León are export-oriented may require a technological upgrade by the Dutch supply industry.
4. In cut flowers, medium to large scale farms are found in Baja California exporting to the Californian market. Development demands are unknown. This group is of interest to Dutch industry, and is best assisted in an integrated approach.
5. Agroparks are large agro-industries (> 10 ha) that operate in integrated market chains focussing on the export market, mainly the United States and Canada. Interesting for Dutch industry for development of integrated concepts requiring innovative and higher investments. Dutch involvement must be through an integrated approach.

6.5 Recommendations for the supply industry

After the discussions with the different representatives of the Mexican industry, and having asked them what would they advise the Dutch supply industry, we came to a series of recommendations.

6.5.1 Substitute “High-Tech” by “Best Fit”

What we encountered during our interviews, is that “High Tech” is often associated with glass, and because this is expensive in initial investments, it is somehow blocking the incorporation of high-tech items into mid-tech arched/ multi tunnel greenhouses. This harms instead of helps the Dutch Supply Industry (with the exception of the glass greenhouse suppliers).
As long as the term “High Tech” keeps on being associated with a glass greenhouse cover it is going to be very difficult to implement advanced (internal) greenhouse technology. In different discussions, when “high tech” was mentioned, the interviewed reaction was “if you mean glass, we are not interested”.

There are surely good arguments to choose for glass:

- Duration (plastic needs to be renewed every three years, creating a waste disposal problem)
- Light transmission (in winter, when prices are best, 10-15% less light costs a lot of production)
- Weather resistance (plastic is easily blown away by high winds)
- Easier cleaning and maintenance (dust accumulation is severe and can also reduce light; glass is easy to clean)
- Easier disease prevention (in plastic it is easier to have holes, breaks, etc.)

However, glass is still seen as expensive by the Mexican Industry, but a good comparison of the costs compared to the return, and considering the above-mentioned arguments is lacking. Good to mention is that growers having glass confirm to have higher running costs than in comparable plastic operations, what makes difficult to obtain benefits.

It is therefore important to separate the technology of the installation from that of the greenhouse construction, specially the technology that contributes to a more sustainable greenhouse horticulture. Market opportunities are probably much larger for the installation than for the construction.

6.5.2 Keep on improving 'High-tech'

A few examples of new developments, what we could call "High-Tech plus" considerably increase the sustainability of protected horticulture, such as new cover materials (diffuse glass, Near Infra Red blocking or absorbing plastic), the energy source, more sustainable energy sources than natural gas (sun energy, geothermic energy, wind energy), combinations of both (Fresnel-lenses incorporated to the greenhouse cover, that block excessive light without requiring screens or whitewash and focus the excess light to produce both caloric and electric energy). Some of these technologies (diffuse glass and coatings), are ready to be applied in Mexico after a good evaluation of the economic feasibility. Others are still in development in The Netherlands (sun panels or Fresnel lenses in the roof), and can inspire new local development. There are new developments being examined in passive, Mediterranean greenhouses (like Near Infra Red absorbing plastic additives or day-heat storage: the heat collected during the day is used during the night to warm up the greenhouse). Developing the most suitable new ideas together with Mexican entreprises can lead to great innovations in the Mexican Horticultural sector.

6.5.3 Incorporate "high-tech elements" in mid-tech greenhouses

The current 'High Tech" definition does not consider the transition pathways from low to medium tech, and from medium to high tech. High-tech elements can be gradually incorporated in a medium-tech greenhouse without changing the total system or even without changing the outer structure of the greenhouse. This kind of transition should be (and is in some policies, see FIRA special credits for projects with an emphasis on the use of sustainable horticulture), encouraged by the governmental policies, especially those contributing to a lower environmental impact and a higher return of investment. A few examples are named here.

6.5.3.1 Drain water re-use

A nice example is recirculation of nutrient solution. Only a few of the so called "High Tech" greenhouses in the Agropark of Queretaro have a recirculation system with UV disinfection. Recirculation considerably reduces water and fertilizer use.

6.5.3.2 Integrated Pest Management

It is a misunderstanding that Integrated Pest Management only makes sense when climate can be optimally controlled. There are many examples of successful pest control in mid-tech greenhouses in different parts of the world (e.g., East Africa). The reduction in pesticides is an important method to create investment capacity, to increase the inocuity of the produce, and food safety in order to access certification.

6.5.3.3 Heating by means of solar heated water

Heating with gas burners above the crop is at this moment considered to characterize the Mid-Tech level; however, the heating needs are not the same for all areas, and so for areas with only a few cold nights a year or a short cold period in winter, other, cheaper systems can be developed or used. Ceickor is experimenting with a system in which well water, extracted at some wells at temperatures above 40 °C, is warmed up by the sun during day time in an easy system of plastic tubes to 60 °C, and used to heat the greenhouse at night and in colder days.

6.5.4 “Tropicalize” Dutch technology

A recommendation that we have heard a number of times is to “tropicalize” the Dutch Technology. The interviewed persons believe that Dutch technology is very good, excellent, but often too expensive for the Mexican situation. Besides, in most cases, it cannot be applied directly to the Mexican circumstances, as the climatology, the knowledge level, and the country’s cultural and social features are different. The Dutch, so we were told, try to sell their technology without looking at the needs of the industry. It is not a question of deciding to increase the sales of a certain existing product, but to use the knowledge derived from the use of these successful products to develop new products special for the Mexican horticulture sector. Most products are easy to simplify or to modify to be made suitable for the Mexican situation.

Practical experience confirms this belief, and a few examples are worth to mention:

- A grower started operating in a from the Netherlands fully designed, packed and shipped equipped greenhouse that was assembled in Mexico. The greenhouse turned out to be so sophisticated that some of the features could not be used and had to be disabled, as for instance a sensor-directed transport system. Also the boiler was over-dimensioned for the Mexican needs, as the required warmth capacity was calculated for the Dutch situation.
- Successful companies know the industry and have adapted their products to the Mexican situation: as examples they can mention Mardenkro, with their Reduheat, a white-wash with a NIR reflecting component that reduces the total heat in the greenhouse
- Berg products have developed harvest-cars with wheels (instead of the sole-Dutch design that rides over the heating rails).

6.5.5 Demonstrate the technology under local conditions

The utility of a certain technology needs to be locally proved. To associate with local growers in order to show your technology is a well-heard recommendation. There are several test centres in the country that would be welcoming technology to test under local conditions.

6.5.6 In Mexico, price counts

When the Mexican is looking for new technologies, they first look at the price, then at quality and productiveness. Making the products affordable for the Mexican is as important as making the products suitable for the local conditions. Cost reducing innovations, from the manufacturing and shipping to the way the products are sold can contribute to a cheaper product. An idea for instance for the case of natural enemies, do not ask a price for each bottle, but agree a price per m^2 that ensures a pest-free (or almost) crop. Sending a technician from the Netherlands to solve problems takes too long, and it is too expensive, since the technician is usually charged at Dutch price level, which is prohibitive for Mexican growers.

6.5.7 In Mexico, personal contact counts

Make sure that you have a local representative. Certain growers do not even want to talk any further with Dutch representatives that do not live in Mexico. For the customers, physical presence is essential. Telephone contact with The Netherlands is only possible in the morning because of the time difference, and it is expensive. If presence is difficult, associate with local companies (but beware of the reputation of the companies).

6.5.8 Market focus

Especially for the national market, producers are mainly organized according to the logistics of production and (input) supply. This means that products or a variety of products (flowers and ornamentals) are offered in blocks according to producer, not according to product specifications. In spite of governmental efforts towards the clustering of small holders into commercial units, the clusters are not always used as joint marketing channel and individuals continue having their own buyers. Thus scale and homogeneity of products offered leaves room for improvement, which can be achieved through improved coordination of production methods and green house management.

6.5.9 ADAPT, not ADOPT; "The adaptive greenhouse"

Repeatedly we were told by the different persons we spoke that the Dutch supply industry of greenhouses made the mistake of trying to export their greenhouses without adapting them to the multiplicity of climate situations of Mexico. Adapting the Dutch technology is the real challenge. The president of AMPHAC expressed it as "make a custom-made design, after studying my climate, my winds, my pests and diseases, my región, my market; integrate a packing taking in account the investment and operational costs and the revenues in a particular market".

Wageningen UR has developed a model-based design method for greenhouses, called "The adaptive greenhouse" (Vanthoor, 2011). The method is a very good decision making tool for the design of a custom-made greenhouse as it combines a greenhouse climate model, a plant growth model (tomato) and an economic model.

By using this approach of location specific model based greenhouse design, combined with good arguments (profit and sustainability factors, see Table 34. Hemming and Maaswinkel) and knowledge of available materials, products and components, the chances for the Dutch supply industry in Turkey, where this approach is being followed since a few months, have tripled the forecasted value (Seraculture Project).

Table 34. Sustainability factors and yield / profit (Hemming and Maaswinkel, 2010).

	Glass standard	Glass with CO_2	Glass with fogging	Glass with CO_2 & fogging	Glass with CO_2 & fogging & closed water system	Glass CO_2 & fogging & closed water system & lighting	Glass with CO_2 & fogging & closed water system & insect nets & screens
Use of resources:							
Water consumption [kg produce/m^3]	28.3	41.8	27.1	38.4	49.4	62.3	51.9
Energy (heat) consumption [MJ/kg]	14.7	9.9	14.5	9.7	9.7	4.5	9.2
Produce less environmental loads:							
CO2 application per unit produce	zero	high	zero	medium	medium	high	medium
Nutrient emissions	high	high	high	high	low	low	low
Pesticides applied per unit produce	high	high	high	medium	medium	medium	low
Efficiency of production process:							
Yield per area [kg/m^2]	36.0	53.3	36.4	54.7	54.7	68.9	57.5
Profit per area and year [€/m^2/year]	€6.90	€14.87	€6.74	€15.56	€15.62	€(2.40)	€16.58
Payback period [years]	4.3	3.0	4.4	3.0	3.1	7.9	3.0

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Annex I Horticultural institutes in Mexico and other data sources

List of interviewed persons.

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FOCIR	Project coordinator	Felix Carvalho Horacio Islas Marraquín
SIAP	Director of surveys and Geography	Gerardo Elizarrarás Rios, MSc.
FIRA	General Director	Rodrigo Sánchez Mújica, MSc.
AMCI	CEO	Jesus Chávez Martínez
SAGARPA	Director General de Vinculación y Desarrollo Tecnológico Director de Insumos para la Producción Agrícola Subdirector Production Input Support	Dr. José Arnulfo del Toro Morales, Dr. Marco Antonio Caballero García Ana Laura Altamirano Pérez
CEICKOR	General Manager Commercial Development Director	Felix Tarrats Jorge Arce
FRESHMEX	General Manager	Oscar Woltman
AMHPAC	CEO	Eric Viramontes
DIVIMEX	Marketing manager	Jaime Tamayo
HORTIMAX México	General Manager	Bram Vanthoor
AWETA México	General Manager	
SERVIAGRO del BAJíiO	Founder of the CONMEXFLOR	Fernando Correa
Feria Internacional Habitat Verde	President	Ing. Gerardo Lopez Noriega
HOME AND GARDENS	General Manager	Ing. Mariano Oropeza
CDT FIRA Tezoyuca	Specialist-in-chief Promotor	Marco Antonio Guzmán Nogueda on behalf of José Villasana Ing. Edibel Leyva de la Cruz
CONAPLOR		Julián Ibarra
CONAPLOR (visitor)	Grower in Costa Rica	Rogelio…
UNIVERSIDAD DE CHAPINGO	Coordinator of the new BSC horticulture	Armando Ramirez Arias

List of horticultural institutions in Mexico

SAGARPA Secretaría de AGricultura, Ganadería, Desarrollo rural pesca y alimentación. www.sagarpa.gob.mx
Municipio Libre 377
Piso 11-A
Col. Sta. Cruz Atoyac
Tel. +52 55 38 71 10 55
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AMHPAC Asociación mexicana de horticultura protegida. www.amhpac.org
Juan Carrasco 787 Nte. Col Centro
80000 Culiacán, Sinaloa

FIRA Fundación para la Innovación y reforma Agroalimentaria. www.fira.gob.mx
Periférico Sur 4300
Col.Jardines del Pedregal
Del. Coyoacan
04500 México, D.F.
Tel. 52 55 5449-1901

ASERCA Apoyos y servicios a la comercialización agropecuaria. www.aserca.gob.mx
Av. Municipio Libre #377, Col. Santa Cruz Atoyac
03310 México D.F.
Tel. 52 (55) 38 71 73 00

INTAGRI Instituto para la innovación tecnológica en la agricultura. www.intagri.com.mx
Ave. Irrigación 105
Conj. Comercial Excelaris
Local 20-A
38015 Celaya, Guanajuato

AMCI Asociación mexicana de constructores de invernaderos. www.amci.org.mx
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Col. Nápoles, Del. Benito Juárez, México D.F.
C.P. 03810 WORLD TRADE CENTER
Tel. 52 (55) 55.84.02.43

FOCIR Fondo de Capitalización e Inversión Rural. www.focir.gob.mx
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INIFAP - Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. www.inifap.gob.mx
Avenida Progreso No 5,
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SIAP - Servicio de Información Agroalimentaria y Pesquera. www.siap.gob.mx
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CIDH Comision para la Investigación y Defensa de las Hortalizas. www.cidh.org.mx
Part of the Confederation of Agricultural Associations of the State of Sinaloa CAADES

Product Systems in Mexico

General information: http://www.sagarpa.gob.mx/agricultura/Publicaciones/SistemaProducto

CONAPRO Comité Nacional Sistema Producto Ornamentales, A. C. -
Ignacio de la Llave no. 105, Salud
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Local Sistema Producto Ornamentales:

Mexico City Comité Sistema Producto de Ornamentales en el Distrito Federal www.spodf.com.mx
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State of Jalisco Comité Sistema Producto Ornamentales de Jalisco
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State of Morelos Consejo Estatal de Productores de Ornamentales de Morelos
Fraccionamiento de Cuauhnahuac
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POMSA Productores de Ornamentales de Mexico
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Other institutions relevant for ornamentals

Consejo Consultor Verde, A. C. www.guiaverdemexico.com
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Data sources for statistics and background information on Mexican horticulture

http://www.ers.usda.gov/Search/?qt=mexico
For background studies in Mexican agriculture/horticulture in relation to US.

http://www.ers.usda.gov/publications/vgs/VGSTables.htm
For data on vegetables production.

http://www.siap.sagarpa.gob.mx/index.php?option=com_wrapper&view=wrapper&Itemid=350
Data from Mexican bureau of statistics on agriculture, climate, geography etc. Web page does not work properly.

http://faostat.fao.org/
For production, trade, food supply and prices of vegetables (most data up till 2007 or 2008).

http://data.un.org/
Data from UN on numerous issues, including national accounts, population, industry employment, exchange rates, etc. But data for Mexico may be scarce. Data on value added in agriculture is available for Mexico until 2007.

http://data.worldbank.org/topic/private-sector
Data from the World Bank. See the Country profiles. E.g. there is an indicator on 'ease of doing business'. This has to do with regulations. Mexico is ranked 41 on this index. In comparison Denmark is ranked 6, Netherlands 29, China is ranked 78, and Russia 116.

http://www.mexicocalidadsuprema.com.mx
Information about certification systems, certified producers, education about food safety.

www.inegi.gob.mx
statistics on Mexican economy, social aspects, census of families, agricultural census, companies, etc.

www.senasica.gob.mx
animal health and phytosanitary issues / imports and exports documents

USDA - http://www.usembassy-mexico.gov/eng/efas.html

MexBest. www.mexbest.com
(list of Mexican exporters - many certified). This database belongs to SAGARPA (ASERCA)

Guia Verde México www.guiaverdemexico.com
Online directory of companies and organizations in the ornamental business

Ministry of Economy. www.economia.gob.mx

Trade statistics:

SITA http://comtrade.un.org/

Foreign Agricultural Service. http://www.fas.usda.gov/gats/default.aspx

SNIIM Sistema Nacional de Información de Mercados. www.economia-sniim.gob.mx Horticultural prices.

http://www.economia.gob.mx/swb/en/economia/p_Estadisticas_de_Comercio_Internacional

http://geo-mexico.com/?p=3577

Annex II Production costs and yields for fresh tomato produced with high technology

Production costs (in USdollar)[1] fresh tomato in greenhouse high technology Annual cycle 2006-2007 in Parral, Cuauhtémoc and Nuevo Casas Grandes, Chih.			Enterprise 1		Enterprise 2		Enterprise 3		Enterprise 4	
[1] Original production in MX pesos, calculated at 2006 rate of MX$10,50 per dollar										
Key indicators										
Size of enterprise (total m2)			45,240		50,000		40,000		20,000	
Yield per Unit (kg/m2)			40		27		56		28	
Average sales price (US$/kg)			1.8		1.5		1.0		0.6	
Average export sales price (US$/kg)			2.1	78.3%	2.4	44.9%	1.1	80%	0.7	50%
Average domestic sales price (US$/kg)			1	21.7%	0.7	55.1%	0.7	20%	0.5	50%
Total income			739,048		392,114		558,933		160,000	
	Product: fresh tomato		739,048		392,114		558,933		160,000	
Total operation costs			582,267		406,422		440,099		223,009	
	Variable costs									
		Seed/seedlings	10,854	1.9%	13,407	3.3%	17,669	4.0%	7,381	3.3%
		Substrate cultivation	32,805	5.6%	837	0.2%	14,674	3.3%	11,333	5.1%
		fertilizers	15,570	2.7%	18,393	4.5%	30,428	6.9%	13,799	6.2%
		packaging	68,975	11.8%	32,170	7.9%	74,155	16.8%	17,143	7.7%
		Electric energy	10,227	1.8%	3,057	0.8%	11,620	2.6%	8,213	3.7%
		heating gas-CO2, diesel	53,688	9.2%	75,588	18.6%	94,725	21.5%	14,377	6.4%
		Quimical /biol. inputs	41,728	7.2%	16,822	4.1%	4,314	1.0%	2,776	1.2%
		water	290	0.0%	189	0.0%	2,287	0.5%	0	0.0%
		labour	60,591	10.4%	86,089	21.2%	76,320	17.3%	80,619	36.2%
		transport	101,471	17.4%	24,106	5.9%	28,126	6.4%	10,563	4.7%
		marketing	86,176	14.8%	37,674	9.3%	17,964	4.1%	3,651	1.6%
	Total variable costs		482,376	82.8%	308,333	75.9%	372,282	84.6%	169,856	76.2%
	Fixed costs									
		administration	23,905	4.1%	24,339	6.0%	13,122	3.0%	5,953	2.7%
		depreciation of assets	75,986	13.1%	67,839	16.7%	47,602	10.8%	42,114	18.9%
		other fixed costs (maintenance)	0	0.0%	5,912	1.5%	7,092	1.6%	5,086	2.3%
	Total fixed costs		99,891	17.2%	98,090	24.1%	67,817	15.4%	53,153	23.8%
Assets			1,256,690		941,320		785,026		429,524	
Revenue										
	With depreciation		156,781		-14,309		118,835		-63,009	
	without depreciation		232,767		53,530		166,437		-20,895	
Return on assets										
	With depreciation		12.5%		-1.5%		15.1%		-14.7%	
	without depreciation		18.5%		5.7%		21.2%		-4.9%	

Annex III SWOT analysis

The Dutch supply industry recently analysed its position on the Mexican market (Wassink et al., 2011). The SWOT analysis is reproduced below.

Strengths	Weaknesses
High quality products, leading in the international market, continuity, innovative, knowledge development	Insufficient knowledge of agribusiness in Mexico, which is large and diverse, with many average-sized farms
Innovative, integrated, knowledge-oriented technology for sustainable horticulture	Limited access to governmental institutions, regional and national organizations of growers, and supply companies and fairs
Efficient use of resources	Lack of knowledge of complex financing
Good presence in high-technology segment, actively penetration of mid-technology segment	Insufficient contact with investors, also from USA.
Demand driven solutions, adapted to local needs	No NL platform where growers can become acquainted with NL horticulture
High quality planting material, good varieties, local investments in R&D of breeding and selection	Limited possibilities to demonstrate innovative products
Excellent reputation in fields of pest and disease management, including integrated pest management, and organic growth	Shortage of product specialists, sales agents / distributors, maintenance companies
Opportunities	Threats
MX is top-5 globally in producing vegetables, large USA market, short logistic lines, large and fast growing domestic demand	MX market is large, distant and varied. Cultural barrier: MX trades easer with Latin and North American nations, and Israel.
Link with market developments in USA, more demand for sustainable products, so advanced production technology required, upgrading of existing farms.	If medium-technology farms are upgrading, especially chances for Spain, France, Israel en USA.
Exporters and national distributors demand uniformity, food security, sustainable products of known origin, higher quality, good logistics. Production is adjusted to this.	Government and banks in especially France, and to a lesser extent in Spain and Israel support their companies financially.
NL vegetable and flower companies invest in local-for-local products (for USA/Canada and Mexico), instead of production in Europe	Investments in high technology do not match with simultaneous adjustment to local circumstances.
Modern growers respect breeder's rights, so reproduction of vegetables, flowers and plants is possible.	Corruption and criminality, low trust in public services
NL suppliers can reach a market share of > 50% in high technolgoy. Suppliers of planting materials can enlarge their position	Lack of subsidies in MX for innovative investments that are perceived risky
Upgrading of medium technology to high technology stimulates development of better position of NL companies	Legislation remains problematic. For example, breeders rights remains UPOV78, not UPOV91. Supply of planting material with soil or turf to USA remains difficult. Also phytosanitary limitations
Expected demand for specific solutions at supra-farm level. For example, the Green City concept, use of excess heat of energy companies, water supply, cool chains, etc. create new markets.	Increased competition from other Central and South American countries on USA market.
Governmental institutes, universities and other governmental services appreciate to be trained in modern horticulture	MX drug related criminality

1 http://www.elobservadordiario.com/el-pais/4817-inauguran-centro-de-capacitacion-para-agricultura-protegida-en-san-luis-potosi