Highest potential CEA locations in the world for Dutch CEA industry to invest in

Final presentation

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Photos: ©Shutterstock

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Agenda

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   3. Methodology
   4. Definitions of High-tech and Mid-tech
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   9. Top 5 Countries
4. Next steps
5. Closure

Agroparque Queretero, Mexico AGROPARK – High-Tech Greenhouse Cluster

Source: Trias Westland, © Carel Kramer

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Objectives and expected results

- The objective is to develop a world map with the highest suitability for CEA locations and two lists of top 5 countries for high-tech and mid-tech greenhouses, creating focus to invest in by businesses. This map is created by synthesis and application of existing knowledge and data.

- The result of the project is a concise report and PowerPoint presentation with final results.

Limitations, Constraints

- Not included:

  - Present (investment) policies of governments;

  - Private investment programmes;

  - Legal restrictions e.g. on water usage of lakes;

  - Restrictions on imports and exports (e.g. tomato from Morocco to EU);

  - Availability of local knowledge and expertise.

- Limited data on growth rates

Mid-tech greenhouse Kentucky, USA

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Definitions of High-tech and Mid-tech

- A high-tech greenhouse is defined as a multi-arched structure with a transparent roof and walls, with a cover made of plastic or glass, with at least 5 of the following 7 technical installations:
  - a climate control unit steering at least temperature and humidity (through flexible ventilation),
  - heating or cooling system,
  - irrigation system (A/B system),
  - moving radiation screens,
  - growing in artificial substrates,
  - artificial lightning,
  - usage of integrated pest management.
- A mid-tech greenhouse is defined as an arched multi-tunnel covered in plastic with a height ranging from 4 to 4.5 meters, with less than 5 of the 7 technical installations
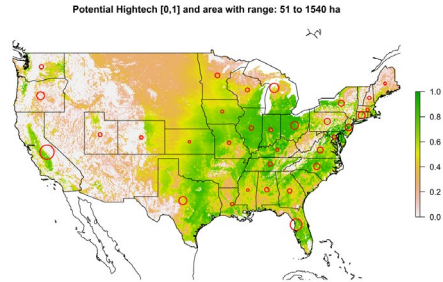
©Appharvest, Kentucky, USA

Methodology: Three perspectives

Potential Hightech [0,1] and area with range: 51 to 1540 ha

Global detector

(potential areas)

- Climate maps

- Water

- Infrastructure

- Geographic aspects

Market Explorer

(Potential market)

- Import, production, consumption

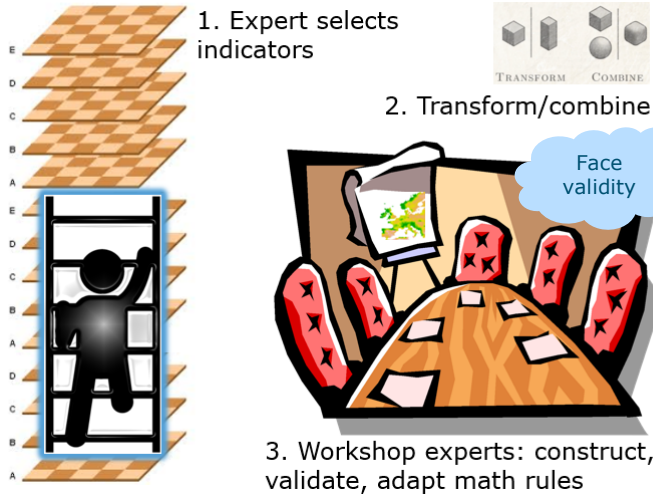- Country aspects, e.g. Easy doing business , Living standards

Desk research

(Existing potential growth areas)

- Where is CEA located?

- What type of CEA?
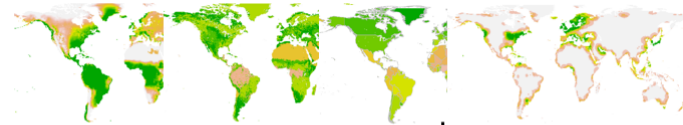
- What is the development?

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Method Global-Detector

1. Expert selects indicators

2. Transform/combine

3. Workshop experts: construct, validate, adapt math rules

Face validity

4. Knowledge engineer builds model in R and runs it worldwide

Global-Detector

5. Face validation by expert

```
foptSP<-function(x,mi,r1,r2,ma,thr){
    L=pmin(1,fmaxSP(x,mi,r1,0))
    R=pmin(1,fminSP(x,r2,ma,0))
    m=pmax(thr,pmin(L,R))
    return(m)
}
HighTech=(foptSP(KGclimate$avgTemp,5,7,11,13,0)^1*
    foptSP(KGclimate$Straling,750,900,1100,1250,0)^1)^(1/2)
```

Adapt 'on the fly'

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Global Detector Indicators

Indicator	R	Mid tech Belang	Mid tech Range/params	High tech Belang	High tech Range/params
Max zomer temp&RV (wet ball)	-	1	[1:<26.5dg ; 0>31.5dg]	1	[1:<28dg ; 0>33.0dg]
Niet te heet (rekening houden met diff)	-	2	Nachttemp<18 ok ; (max-diff)/10-(max-20)/20	2	Nachttemp<20 ok ; (max-diff)/10-(max-22)/20
Straling	+	1	Jaar[800-1800]; winter[500,1200] W/m2	1	Jaar[500-1500]; winter[300,900] W/m2
Cyclonen	-	0,5	[50,250] km/hr ondergrens 0	0,5	[100,300] km/hr ; ondergrens 0.1
Tornados USA	-	0,5	[0,0.015] #events/km2 1950-2022	0,1	[0,0.015] #events/km2 1950-2022
Niet te koud		2	[-10,0]	2	[-15,-5]
Sneeuw		1	[0,1] score	1	[0,1] score
Overall Klimaat		**2**		**1**	
Neerslag 5 droogste maanden (aaneengesl.)	+	0,5	[50,….,100] mm/periode	0,5	[25,….,50] mm/periode
Water availability	+	1	[0,1] score	0,5	[0,1] score
Grondwater	+	0,5	diepte [-80,-10] meter	0,5	diepte [-80,-10] meter
Overall Water		**1**		**1**	
Bereikbaarheid besteedbare markt	+	2	[0,200] zie opmerking	3	idem
Nabijheid vliegvelden (straal 250km)	+	0,5	[0,1] score	1	
Nabijheid en aantal havens (straal 250km)	+	1	[0,1] score	1,5	
Overall Infrastructuur en Markt		**1**		**2**	
Aardbevingsgevoeligheid	-	0,5	[0.5,5] m/s^2	1	[0.5,4] m/s^2
Electriciteitsvoorziening	+	1	[0.25,1]	2	[0.25,1]
Overall Diversen		**0,5**		**0,5**	
Rotsen	-	1	0/1		0/1
Veengrond	-	1	0/1		0/1
Sneeuw	-	1	0/1		0/1
Bedekt met bos %					
Bedekt met natuur % } MAX	-	1	[0,100]		[0,100]
Bedekt met protected area %					
Populatie dichtheid (N/km2)	-		[250,1500]		[250,1500]
Helling (gemiddelde 5'x5' grid)	-		[3,20]		[3,10]
Hoogte in m	-		[2500,3000]		[2500,3000]
Water bedekking	-		[80-100] ; <80% geen restrictie		[80-100] ; <80% geen restrictie
Overall restricties		**2**		**2**	

Results: Example USA

Aspect Climate High-tech

Aspect Market & Infrastructure High-tech

Potential High-tech
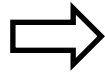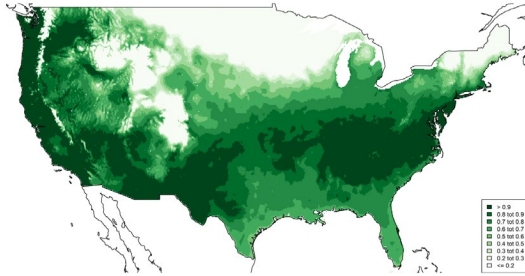
Aspect Water High-tech
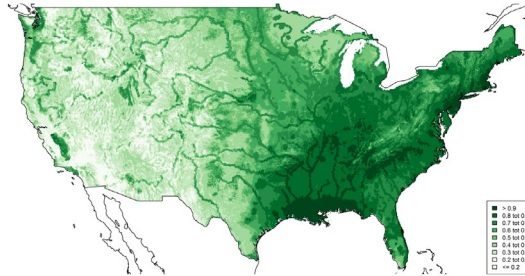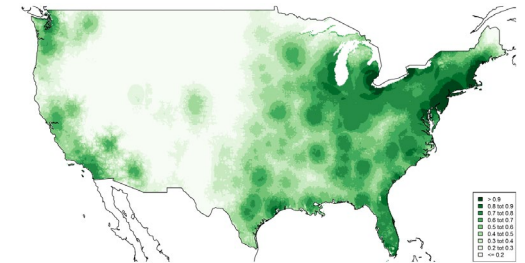
Aspect No restriction High-tech

+ Seismic activity and Estimated electricity

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Other maps
https://doi.org/10.5281/zenodo.10654174
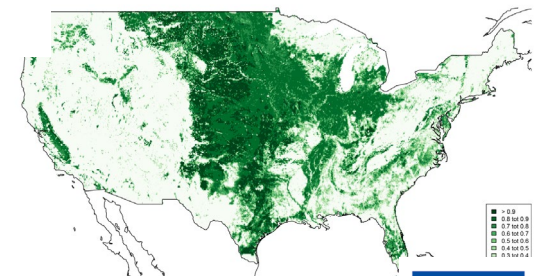
- Global-Detector

- Countries:

  - USA, Canada, Mexico

  - Netherlands, Belgium, Germany, Spain, France, UK, Poland, Turkey, Ukraine

  - China, India, Australia, South Korea, Japan, Kazakhstan

- Regions: World, Northwest Europe, North Africa, Gulf region

Potential Mid-tech and High-tech (Global Detector)

Mid-tech Classification

Country (relative)	Country (absolute)
France	USA
Germany	Brazil
UK	Australia
Uruguay	India
Ireland	Sudan
Spain	China
Netherlands	Libya
Italy	Saudi Arabia
Belgium	Argentina
USA	Algeria
Denmark	France
Ukraine	Mali
Hungary	Chad
Libya	Egypt
Poland	Niger
Syria	Nigeria
India	Indonesia
Czech Rep.	Iran
Argentina	Spain
Brazil	Ukraine

USA
France
India
Libya
Brazil
Germany
Spain
Argentina
Sudan
Saudi Arabia
UK
Ukraine
Uruguay
Italy
Egypt
Mali
Niger
Chad
Australia
Nigeria

High-tech Classification

country	country
France	USA
Germany	Brazil
Denmark	China
USA	India
UK	Saudi Arabia
Netherlands	Australia
Belgium	France
Ireland	Russia
Poland	Sudan
Italy	Argentina
Ukraine	Ukraine
Hungary	Germany
Spain	Libya
Uruguay	Spain
Lithuania	Egypt
Czech Rep.	Mali
Kuwait	UK
UAE	Nigeria
Romania	Iran
Saudi Arabia	Poland

USA
France
Germany
UK
Ukraine
Saudi Arabia
Spain
India
Poland
Italy
China
Uruguay
Argentina
Denmark
Thailand
Romania
Brazil
Ireland
Hongaria
Netherlands

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Market Explorer Model Structure

Data sources: Comtrade; FAOstat, Worldbank, Tranparency Int., CIA, Fund for Peace (Fragile)

Import alle landen **hoog**

Import ontwikkeling **toenemend**

Productie (landelijk) **hoog**

Productie ontwikkeling **toenemend**

Import groente & fruit **hoog**

Aspect Import

Aspect productie

Consumptie (landelijk) **hoog**

Consumptie ontwikkeling **toenemend**

Consumptie per capita **hoog**

Aspect consumptie

Prijs **hoog**

Perspectieven investering

Gesorteerde lijst van landen met de meeste perspectieven voor **product P**

Aspect COUNTRY

Mediaan inkomen **hoog**

GDP per capita **hoog**

EDB **gunstig**

Fragile **laag**

Corruptie **laag**

Logistiek **goed**

Urbani-satie **hoog**

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Top 20 Market Explorer Tomato and Strawberry

- Tomato:

Germany, Netherlands, France, USA, Spain, Italy, Japan, UAE, **UK, Belgium**, Israel, Poland, Russia, Portugal, Bulgaria, Oman, **Switzerland**, **Sweden, Canada**, **Finland**

- Strawberry:

UK, Netherlands, Belgium, USA, Canada, Spain, Germany, France, Japan, Belarus, Norway, **Switzerland**, Mexico, Denmark, **Sweden**, **Finland**, **Italy**, Ireland, Australia

© Anthura, NL

Market explorer Power BI

- First, you need to install MicroSoft Power BI on your computer. Next you download 5 files below from https://doi.org/10.5281/zenodo.10654174 and store then in 1 folder. Then you open the .pbix file.

  - MarketExplorer.pbix

  - CombiTab_Tomato.xls.x

  - CombiTab_Strawberry.xlsx

  - TomatoRanking.html

  - StrawberriesRanking.html

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Source: shutterstock

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Desk Research obstacles

- No uniformity in definition

- Language barrier

- Data not available, or data area under glass instead of area glass

- Measurement units

- No data on regions

- No timeline of datasets: development/growth is hard to define

- Lacks import barriers, local regulations, investment programmes
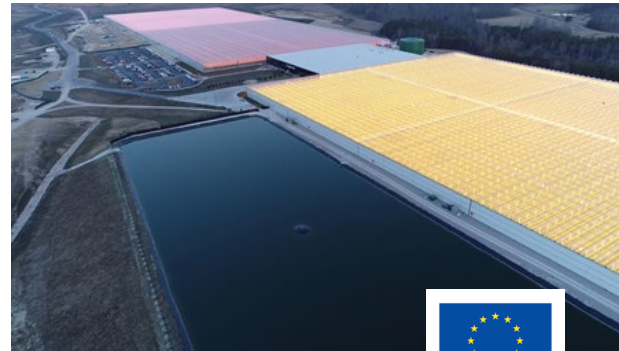
Existing CEA areas (Ha)

Total CEA (ha)	
China	1.894.215
Turkey	81.088
Spain	73.115
Republic of Korea	56.467
Mexico	51.853
Egypt	51.350
Japan	42.164
Morocco	23.770
Algeria	21.025
India	14.366
The Netherlands	10.640
Ukraine	10.325
France	9.834
United States	9.201
Greece	8.404
Tunisia	7.740
Ecuador	6.783
Argentina	6.517
Germany	5.883
Poland	5.574

Total high-tech (ha)	
China	??
Mexico	15.214
The Netherlands	10.540
Turkey	5.963
Belgium	2.726
Germany	2.262
Spain	1.989
Japan	1.595
Poland	1.573
Uzbekistan	1.500
Canada	1.426
Egypt	1.350
Australia	1.153
USA	1.008
Azerbaijan	500
Republic of Korea	367
India	357
Ukraine	335
Romania	316
Tunisia	250

Total mid-tech (ha)	
China	??
Turkey	75.125
Spain	71.126
Republic of Korea	56.100
Egypt	50.000
Japan	40.569
Mexico	36.639
Morocco	??
Algeria	21.025
India	14.009
Ukraine	9.989
Greece	8.264
USA	7.212
France	??
Tunisia	7.490
Ecuador	??
Argentina	??
Colombia	??
Poland	4.001
Germany	3.621

Total existing CEA area in the world

- Total CEA: 2.5 million ha, of which 1,8 million ha in China

- Total glass: approx. 60.000 ha (China excluded)

- Total plastic: approx. 600.000 ha (China excluded)

- This is in line with other sources: e.g. Rabobank, 2020

Type of protected Area 2018	Area 2018 in ha	Estimated growth % per year	Area 2025 in ha
Low-tech (level 1 – 3)	550.000	4%	± 700.000
High-tech (level 4	50.000	7%	± 80.000
Vertical farming	40	15%	± 100

13   Global market exploration for high and mid-tech horticulture   Source: Cuesta Roble 2018, Rabobank 2020

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Regional existing areas and potential maps

- Maps of 18 countries, that can be downloaded from https://doi.org/10.5281/zenodo.10654174

Potential Hightech [0,1] and area with range: 51 to 1540 ha
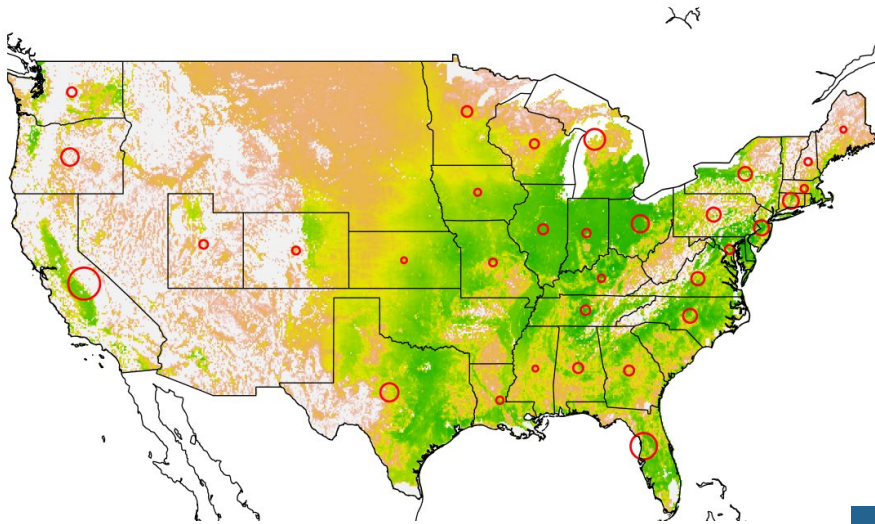
Potential Midtech [0,1] and area with range: 77 to 11975 ha
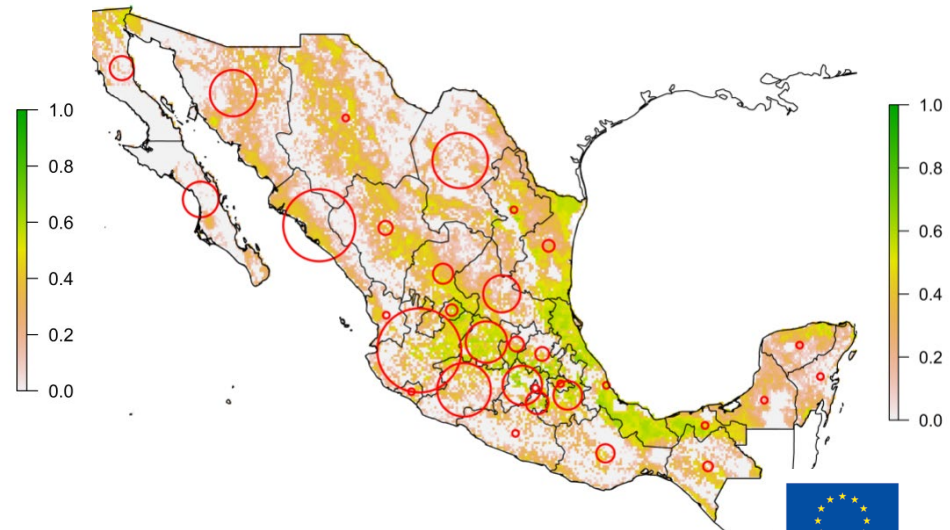
Integration Global Detector, Market Explorer and desk research

Total End score	Total End score MT	Total end score HT
Spain	Spain	USA
USA	France	France
France	USA	Spain
Germany	Germany	Germany
Italy	Italy	Poland
Turkey	Turkey	Netherlands
Netherlands	Poland	Italy
Poland	Netherlands	Japan
Japan	Argentina	Turkey
China	Ukraine	China

Conclusion: Highest CEA potential

Countries with high-tech CEA	Conversion mid-tech to high-tech countries	Emerging high-tech countries
Germany (MT)	**Spain** (MT)	**USA** (MT)
Netherlands	**France** (MT)	**Poland**
Turkey (MT)	China*	Italy (MT)
China*	Japan	Ukraine
Belgium	India	Saudi Arabia
Mexico	South Korea	UK

e for high-tech potential

e for mid-tech potential

raordinarily large area of high-tech as well as mid-tech

Next step: follow-up project

A more thorough assessment with:

- Additional growth percentages for the most important countries;

- Additional national policy of the most important countries, level of available local knowledge, level of investment;

- Additional check on availability of improved datasets on Humidity;

- Impact of climate change;

- Improved interactive interface on data accessibility;

- Differentiated analysis for greenhouse builders, technology installation companies and suppliers of seed and starting materials.

Dalat region, Vietnam

Proposition PPS project 2025

- Public Private Partnership project of the Topsector Horticulture & Starting materials to be submitted 1 September 2024

- Without private commitment in cash and kind no PPS project: the government doubles the private sector input.

- At least 25% of the total research budget has to be in cash by the private sector

- e.g. 25 kEuro in cash for each year and the same in kind in 2025 and 2026 makes a total research project of 200 kEuro

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Thanks for your attention

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