Fachhochschule Südwestfalen
Wir geben Impulse

„Vertical farming“
…more than a hype?

Sarajevo University

November 19th, 2020, Online - Dr. Bernd Pölling

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Co-funded by the Erasmus+ Programme of the European Union

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Vertical farming
Overview

Introduction

Why is that a topic?
- Urbanisation
- „Food deserts“

Types of vertical farming
- Rooftop farms and rooftop greenhouses
- Vertical systems
- Indoor systems / plant factories

Business models

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Vertical farming

Introduction

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Vertical farming

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Vertical farming

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Vertical farming
Introduction

Today‘s focus: building-integrated plant production

- Rooftop farms and rooftop greenhouses
- Vertical systems
- Indoor systems / plant factories

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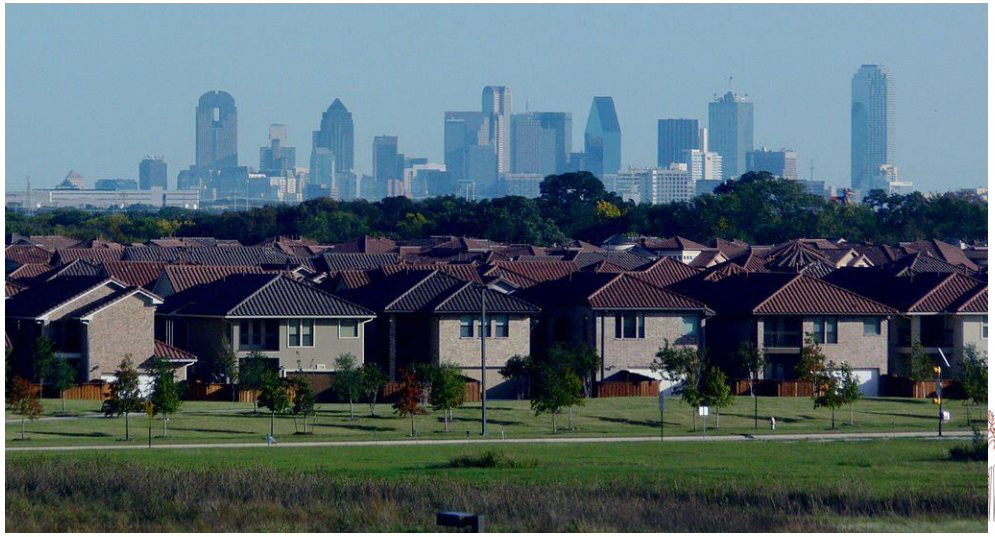
Vertical farming

Why is that a topic?

Urbanisation

- „Urbanised world“
  - ca. 60 mio. new city dwellers annually
  - 2009: 3,4 bio → 2050: 6,4 bio
    - Developing world regions
    - In post-industrial areas declining



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Food deserts

- Distance to healthy and fresh food
- Especially an issue in North America
- Mainly low-income communities are affected

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Vertical farming

Why is that a topic?

Food deserts

*"A **food desert** is an area, especially one with low-income residents, that has **limited access to affordable and nutritious food**."*

(American Nutrition Association, 2017)

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Vertical farming

Building-integrated plant production

Which regions? Which environments?

Vertical farming

Building-integrated plant production

Which regions? Which environments?

Vertical farming
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Building-integrated plant production

- Rooftop farms and rooftop greenhouses
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- Indoor systems / plant factories

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Vertical farming
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Building-integrated plant production

- **Rooftop farms and rooftop greenhouses**
- Vertical systems
- Indoor systems / plant factories

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The German framework conditions for roof-farming

- Flat roofs in Germany
  - 1.2 billion m² = 120,000 ha *(Allplan)*
  - 0.65% of German farmland (18,3 Mio. ha)
- Mainly industry and public buildings
- Competition (solar panels/photovoltaic, terrace, etc.)

Higher shares of flat roofs in other world regions

- North America
- Asia

Vertical farming

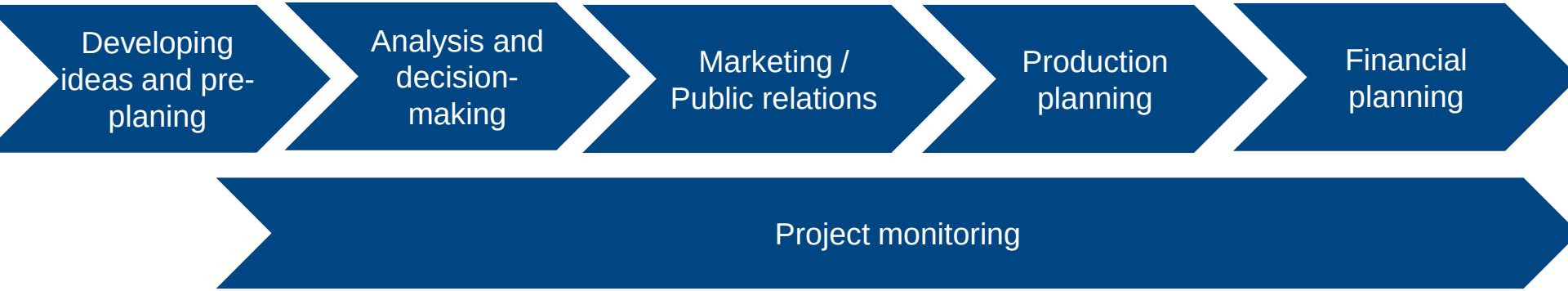
Rooftop farms and rooftop greenhouses

Zero acreage Farming (Zfarm)

ZFarm
Städtische Landwirtschaft der Zukunft

Bundesministerium für Bildung und Forschung

- Insights into a national research project
- from idea to implementation (guidebook)



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Es wächst etwas auf dem Dach

DACHGEWÄCHSHÄUSER ▲ Idee ▲ Planung ▲ Umsetzung

ZFarm
Städtische Landwirtschaft der Zukunft

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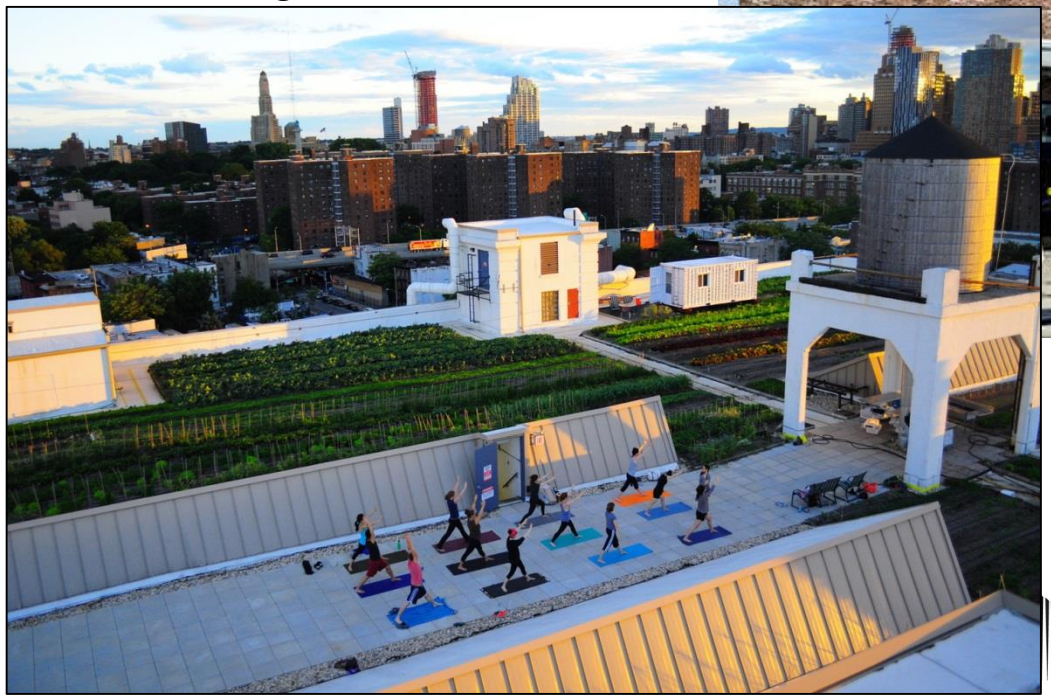
Vertical farming

Rooftop farms and rooftop greenhouses

Developing ideas // Pre-planing: Definition of goals

- commercial
- Quality of life
- Edcuation / Social
- Innovation
- Image



Gotham Greens
Brooklyn Grange

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Analysis and decision-making

Building	Environment
Size	Building structure and density
Slope	Legal aspects
Roof construction	Socio-demographic structure
Sunlight / Shadow	Local interactions
Accessibility	Social infrastructure / facilities
Load capacity/static	„Soft“ site factors
Further building uses	Traffic structure
Height	City structure
Structure/Materials/Fabric	Market and Competition situation
Legal aspects	

Vertical farming

Rooftop farms and rooftop greenhouses

Marketing

- Product policy
- Price policy
- Distribution policy
- Communication policy

Marketing-Mix	
Produktpolitik	▲ Produkteigenschaften (gemäß der Erwartungen und dem Verhalten der Zielgruppe) ▲ Name ▲ Marke ▲ Abgrenzung zur Konkurrenz ▲ Premium-Produkt
Preispolitik	▲ Kostenbasierte Preisbestimmung ▲ Nachfrageorientierte Preisbestimmung
Distributions-politik	▲ Wie ist das (Kauf-)Verhalten der Zielgruppen? Welche (Einkaufs-)Orte sind relevant? ▲ Distributionskanäle (auch Verhandlungsmacht beachten), z. B. Direktvertrieb, Vertragshändler/innen, Produktions-stätte als Erlebnisort
Kommuni-kationspolitik	▲ Image -und Markenbildung (auch über bspw. Zertifizierung) ▲ Erscheinungsbild ▲ Kommunikation (mediale Strategie) ▲ Erreichbarkeit der Zielgruppe und entsprechende Auswahl der Werbeträger/innen, Kommunikatorinnen/ Kommunikatoren

Vertical farming

Rooftop farms and rooftop greenhouses

Baby Kale Medley

Basil

Blooming Brooklyn Iceberg

Bok Choy

Gourmet Lettuce Medley

Greenpoint Oak Leaf

Queens Crisp

Brooklyn Sweets

Rooftop Reds

Vertical farming

Rooftop farms and rooftop greenhouses

Production planung

Produkt	Potentiale	Anmerkungen
Blattgemüse/Salate *Leavy veggies*	Blattgemüse und Salate haben großes Potential, da sie als Schnelldurchläufer innerhalb weniger Tage viel Masse produzieren. Auch hier sollte der Fokus auf ausgefallene oder spezielle Sorten gelegt werden.	Die Produktion konzentriert sich auf den Frischemarkt. Denkbar wäre ggf. eine Weiterverarbeitung zum „Convenience-Produkt": fertig gewaschen, geschnitten und verpackt.
Kräuter *Herbs*	Klassische Küchenkräuter wie Schnittlauch, Petersilie, Basilikum, Koriander oder Dill sind gut für den Frischemarkt produzierbar. Weitere mögliche Produktnischen sind z. B. ausgefallene Kräuter, die auf dem Großmarkt schwer zu bekommen sind.	Der wichtigste Vorteil ist die Frische der Produkte. Daher macht eine Weiterverarbeitung (z. B. getrocknete Kräuter oder Pesto) nur bedingt Sinn, z. B. wenn sonst die Ernte ungenutzt bleiben würde.
Heimische Beerenfrüchte *Berries*	Unter dem heimischen Obst bieten vor allem die Beerenfrüchte gute Chancen für eine erfolgreiche Vermarktung. Dies gilt sowohl für den Frischemarkt als auch für weiterverarbeitete und veredelte Produkte (Marmeladen, Säfte, Trockenfrüchte usw.)	Für den hydroponischen Anbau eignen sich nur Erdbeeren. Alle anderen Beerenfrüchte brauchen feste Substrate.
Kürbisgewächse	Kürbisgewächse sind gut für den Anbau geeignet. Die Produktpalette umfasst Kürbis-, Gurken- und Melonenpflanzen.	Zur Haltbarmachung können Kürbisgewächse gut eingefroren oder eingelegt werden und bieten Potentiale für die Weiterverarbeitung (z. B. Chutneys oder eingelegte Produkte). Auch die Kerne/Samen lassen sich weiterverarbeiten.
Tomaten *Tomatoes*	Seltene Sorten, wie z. B. schwarze Tomaten oder Zebratomaten eignen sich gut für die Vermarktung und erzielen hohe Gewinne.	Für den Anbau von Tomaten empfiehlt sich das Halten eines Hummelvolks für die Bestäubung, da eine Bestäubung der Tomaten ansonsten sehr aufwändig ist.
Fische *Fishes*	Fischproduktion lässt sich durch aquaponischen Anbau mit anderen Produkten verbinden. Durch die Doppelnutzung von Wasser und Nährstoffen ergeben sich ökologische Vorteile.	Für den Verkauf benötigen Fische einen gewissen Vorfertigungsgrad. Eine Zwischenverarbeitung (ausnehmen, filetieren) ist für die meisten Abnehmer erforderlich. Auch eine weitere Veredelung (z. B. einlegen oder räuchern) ist denkbar.
Weitere Produkte	Weitere Produkte, die sich für die Produktion in Dachgewächshäusern eignen, sind Jungpflanzen oder auch Algen.	*Microgreens, algae, …*

Vertical farming

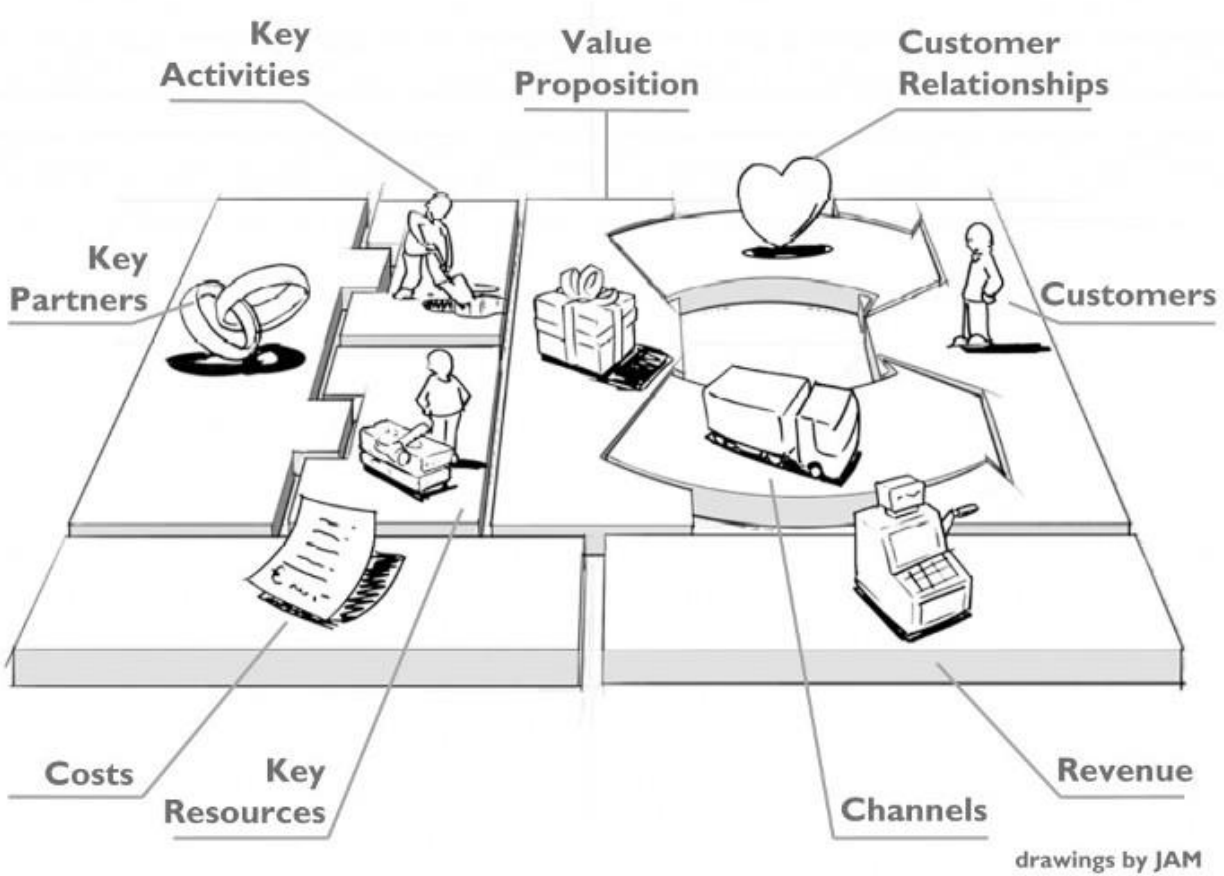
Rooftop farms and rooftop greenhouses

Financial planung

Monetäre Ausgaben
Betriebskosten
▲ Miete/Pacht
▲ Versicherungen, Steuern/Abgaben etc.
▲ Personal
▲ Wartung/Instandhaltung
▲ Kosten für Hygieneüberwachung
▲ Kosten für Biosiegel oder Verbandsmitgliedschaften
▲ Vertriebskosten
▲ Kosten für Weiterverarbeitung und Verpackung
▲ Energie ▲ Wasser ▲ Abfall ▲ Dünger
▲ Setzlinge ▲ Substrate, Erde etc.
▲ Lagerhaltung
▲ Entsorgung von sonstigen Reststoffen

Monetäre Einnahmen
Erlöse aus dem Verkauf von Erzeugnissen
▲ Frische Produkte
▲ Weiterverarbeitete Produkte
▲ Einnahmen aus Gastronomie
Erlöse aus Dienstleistungen
▲ Beratungsleistungen
▲ Vermietung als Event-Location
▲ Schulungen/Workshops

Monetäre Ausgaben
Beratungs-/Transaktionskosten
▲ Statikuntersuchungen
▲ Planungskosten/-entwurf
▲ Bauanträge
▲ Finanzberatungen/Rechtsberatung u. a.
▲ Kosten für Genehmigungen
Finanzierungskosten
▲ Kosten für die Bereitstellung finanzieller Mittel (→ Kapitel Finanzierungs-formen und Förderungsmöglichkeiten)
Investitionskosten
▲ Bauliche Maßnahmen (Ermittlung nach DIN 276)
▲ Gewächshausbau
▲ Technische Anlagen/Anbausysteme (z. B. Hydroponik)
▲ Gebäudetechnik, Ver- und Entsorgung
▲ Anlagen für Weiterverarbeitung und Verpackung



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Vertical farming

Rooftop farms and rooftop greenhouses

How to acquire money…

Finanzierungsform	Bedingungen/Kriterien
Fremdfinanzierung über konventionelle Banken	▲ Höhe des Eigenkapitals der Kreditnehmer ▲ Sicherheiten für den Kredit ▲ Geschäftsplan, Liquiditätsplan und erwartete Gewinn- und Verlustrechnung ▲ Mindestgrenze ca. 50.000 Euro, da ansonsten Prüfkosten höher als zu erwartende Rendite sind
Fremdfinanzierung über „Spezialbanken" (unkonventionelle Geschäftsfelder, wie ökologisches und soziales Unternehmertum)	▲ Gesamtkonzept mit Zielen, Geschäftsmodell und Finanzierungsplan ▲ Verbilligte Kredite für Projekte mit bürgerschaftlichem Engagement ▲ Umfangreiche Kreditwürdigkeitsprüfung, bezieht auch Merkmale der Kreditnehmer/innen und ihres sozialen Umfeldes ein ▲ Sammelbürgschaften als Sicherheit möglich ▲ Genaue Rechenschaft mit speziellem Fragebogen, der auch für die Projektplanung eine gute Hilfestellung sein kann
Mikrofinanzinstitute (staatl. beauftragte Berater/innen): gebührenfreie Mikrokredite 1.000 bis 20.000 Euro	▲ Nach Vorprüfung Weiterleitung der Anträge an die GLS-Bank als Träger ▲ Bewilligung in kleinen Schritten von z. B. zunächst 1.000 Euro und später 5.000 oder 10.000 Euro ▲ Erhöhungen auf bis zu 20.000 Euro ▲ Laufzeit wenige Monate bis max. drei Jahre ▲ Häufig Referenzen bzw. kleine Bürgschaften aus persönlichem und geschäftlichem Umfeld notwendig

Finanzierungsform	Bedingungen/Kriterien
Privatfinanzierung oder „Social financing"	▲ Zusammenschluss von Einzelpersonen und Unternehmen zur Finanzierungsinitiative mit privaten Einlagen ▲ Aufwändige Verträge → Einbindung anderer Kapitalquellen als nur Banken ▲ Höhere Chancen auf konventionelle Kredite
„Crowd funding": anonyme Menge von Kleinkapitalgeberinnen/Kleinkapitalgebern	▲ Unterschiedliche Modelle: Kreditmarktplatz smava (ermittelt für Kredite zwischen 1.000 und 50.000 Euro die günstigsten Angebote) ▲ Spendenplattformen kickstarter.com und visionbakery.com (für kreative Projekte wie auch neuartige Technologien) und betterplace.org (für Non-Profit-Projekte) ▲ Innovestment, Companisto und Seedmatch (explizit für Start-ups, Finanzierungskapital bis zu 100.000 Euro, Kapitalgeber/innen erwerben stille Beteiligungen → kostenloses Feedback und Prüfung der eigenen Projektidee sowie effektives Marketing je mehr Unterstützungspersonen, Multiplikatorinnen/Multiplikatoren)
Sponsoring	▲ Durch Elternvereine im Falle von Schulen oder durch Firmen (Corporate Social Responsibility, Imagegewinn)

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Types of Crowdfunding ?

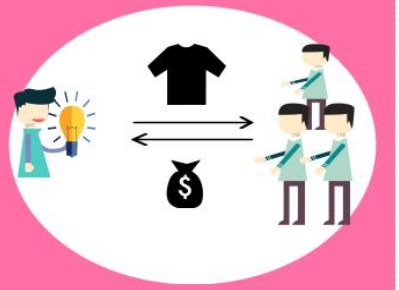
Donation Model

No return for money given

Campaign gathers hundreds of small donations to reach the goal. Donors feel good about the contribution.

Donors

Reward Model

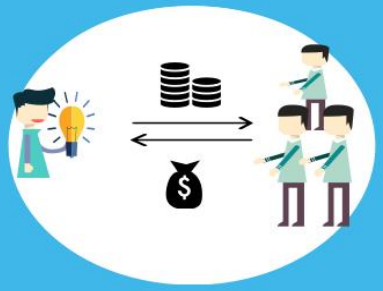


Tangible or intangible reward

Campaign gathers financial contribution in return of some kind of reward. Tangible like T-shirt or In-tangible like recognition.

Supporters

Debt Model



Interest on money given

Investors receive interest in return of the funding provided by them.

Investors

Equity Model

Ownership on money given

Investors receive a piece of business in form of equity in return of the funding provided by them.

Investors

CROWDINVEST
www.crowdinvest.com

Presented By :

Kritika Gupta
Marketing Manager

Es wächst etwas auf dem Dach

DACHGEWÄCHSHÄUSER ▲ Idee ▲ Planung ▲ Umsetzung

ZFarm
Städtische Landwirtschaft der Zukunft

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Vertical farming
Introduction

Building-integrated plant production

- Rooftop farms and rooftop greenhouses
- **Vertical systems**
- Indoor systems / plant factories

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Vertical farming

Vertical systems

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Vertical systems // Productive green walls

Green walls are mainly unproductive
Vertical food production

- Towards the sun
- Challenges:
  - constant supply of water and nutrients
  - Planting and harvesting
  - Yields

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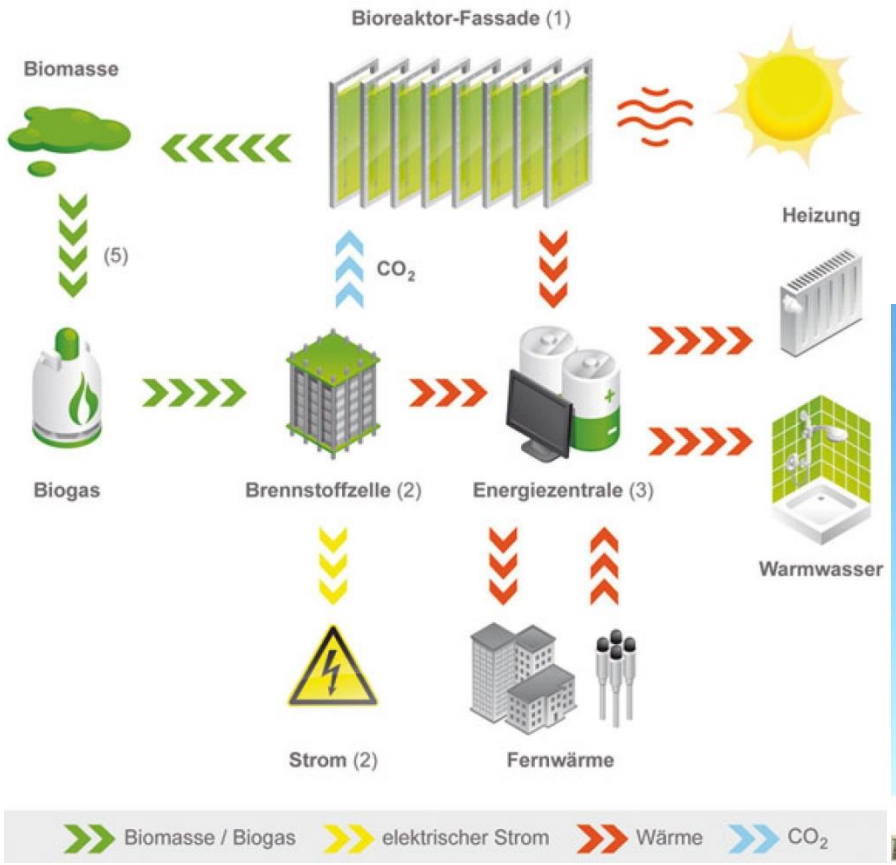
Vertical farming

Vertical systems



Algae house in Hamburg

- Finished in 2013
- IBA Hamburg

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MINT Engineering (Berlin/Dresden)

Building-integrated plant production

- Rooftop farms and rooftop greenhouses
- Vertical systems
- **Indoor systems / plant factories**

Advantages and disadvantages of Indoor-Farming

- Advantages
  - Year-round production
  - Globally applicable
  - indepedent „from outdoor“
    - Weather (extremes)
    - pests
    - etc.
  - Water efficient (circularity)
- Disadvantages
  - High investment costs
  - High operating costs
    - Energy, staff, IT, …
  - Acceptance in the wider society (?)

Advantages and disadvantages of Indoor-Farming

„Controlled Environment Agriculture“

Salads

- Indoor farming: ca. 30-35 days
- Outdoor farming: ca. 60 days

Production costs tomatoes:

- 12 €/kg tomato (DLR Indoor Farm)
- Retail price for regional, bio tomatoes: 4-5 €/kg

Vertical farming

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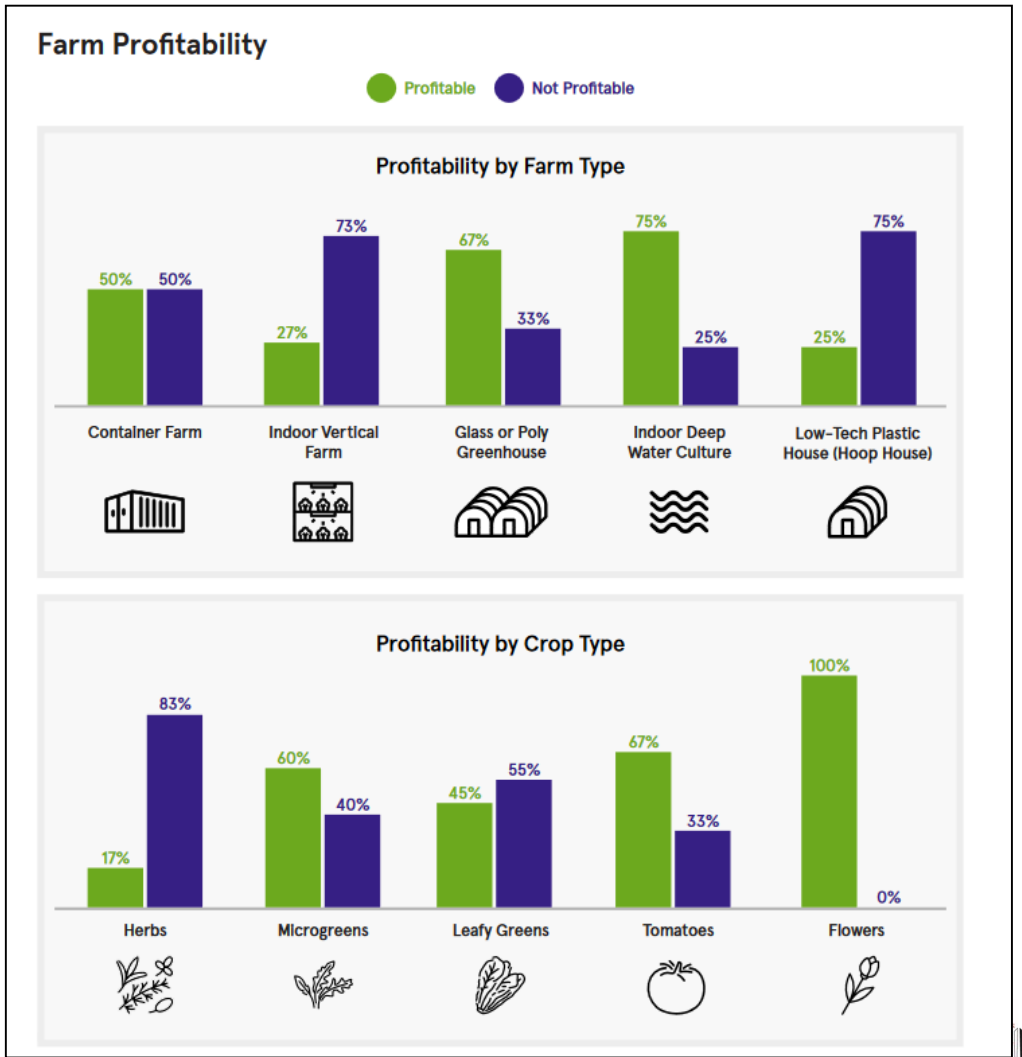
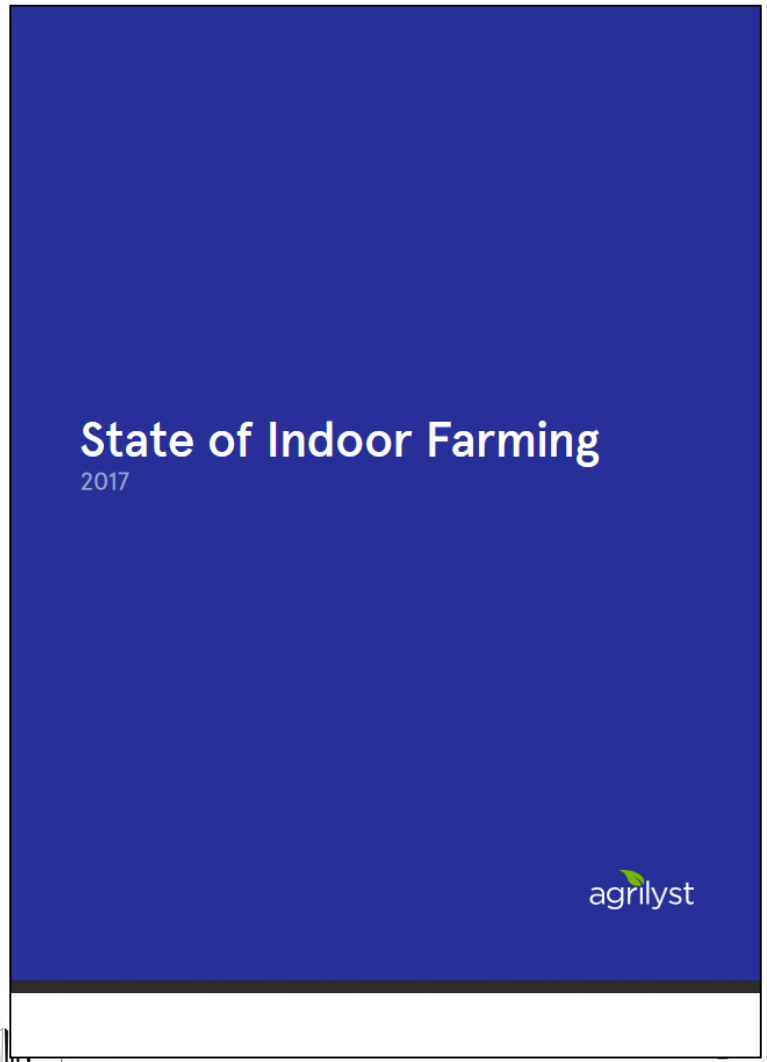
Business models

Vertical farming

Economic figures (USA)





Vertical farming

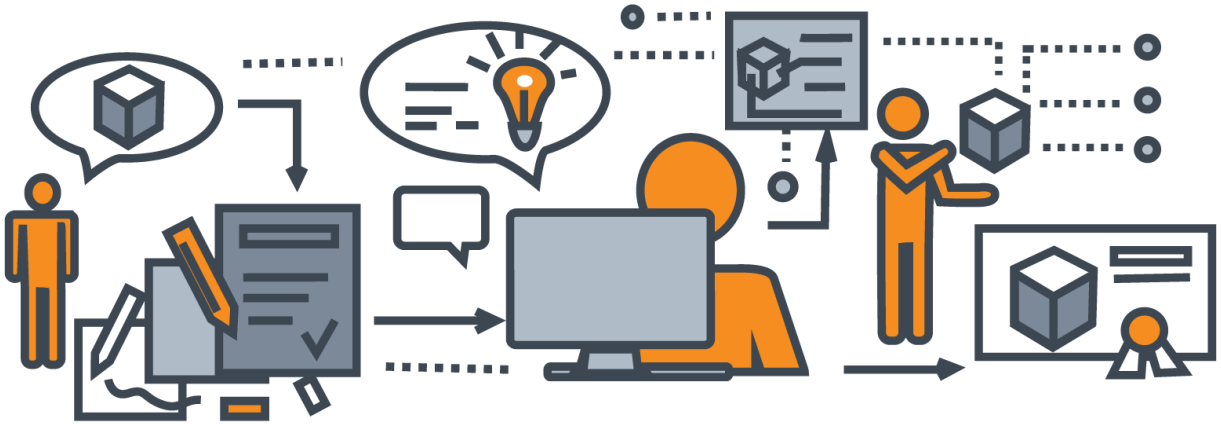
Business models

Restrictions

- Comparable high investment costs
- Often high operating costs (staff, light, electricity, water, sewage, …)
- (tight) limited production quantities

Challenge

- Development of a profitable/economically viable business model



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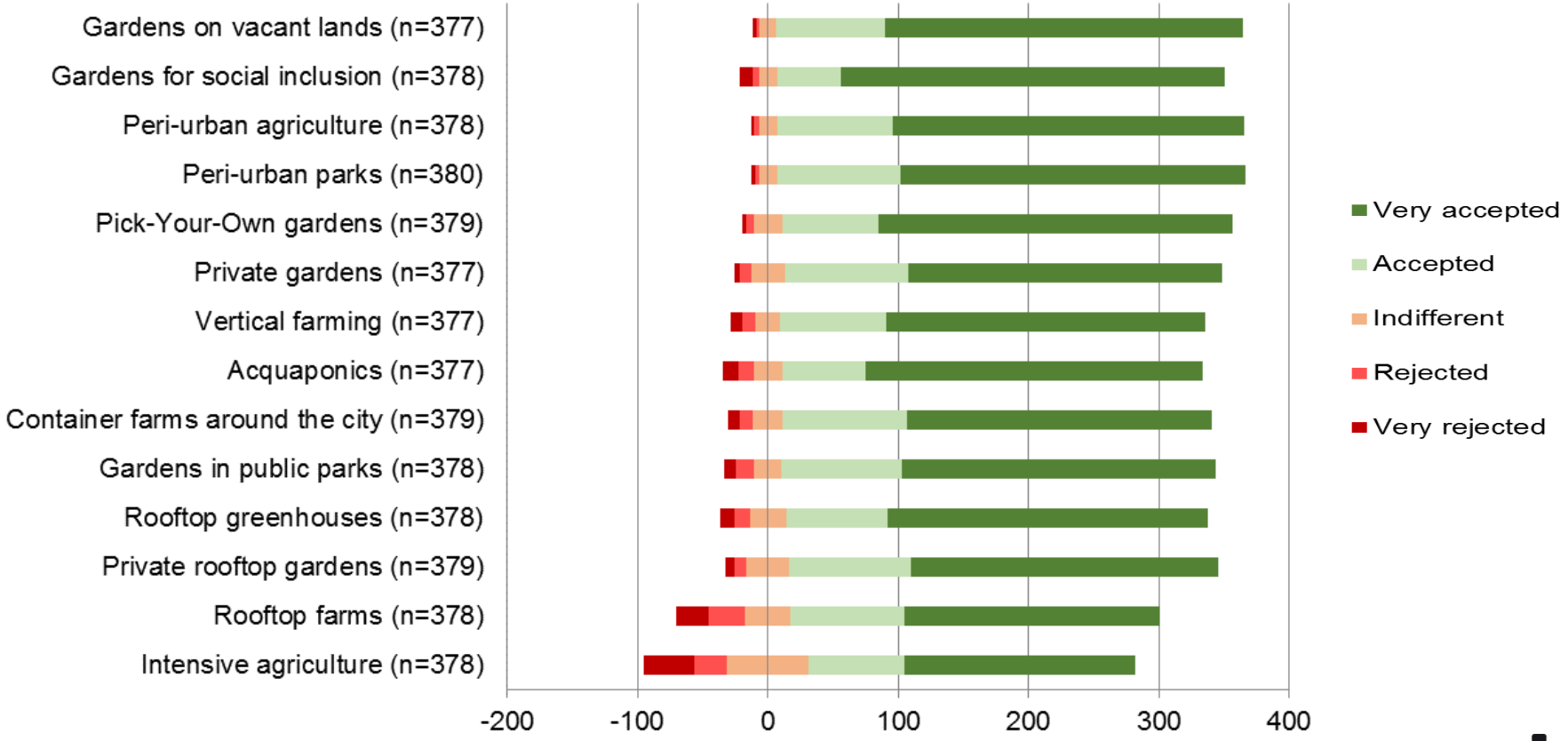
Vertical farming

Business models

Social acceptance of different types of urban agriculture

(Specht et al., 2016; Sanye-Mengual et al., 2017)



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Vertical farming

Business models

Differentiation and Diversification

- „Premium Price“ (Differentiation)
  - Promoting you USP
  - Local high-priced purchase
  - Restaurants, cafés, retailer stores, …
  - Alternative concepts (online, CSA, …)

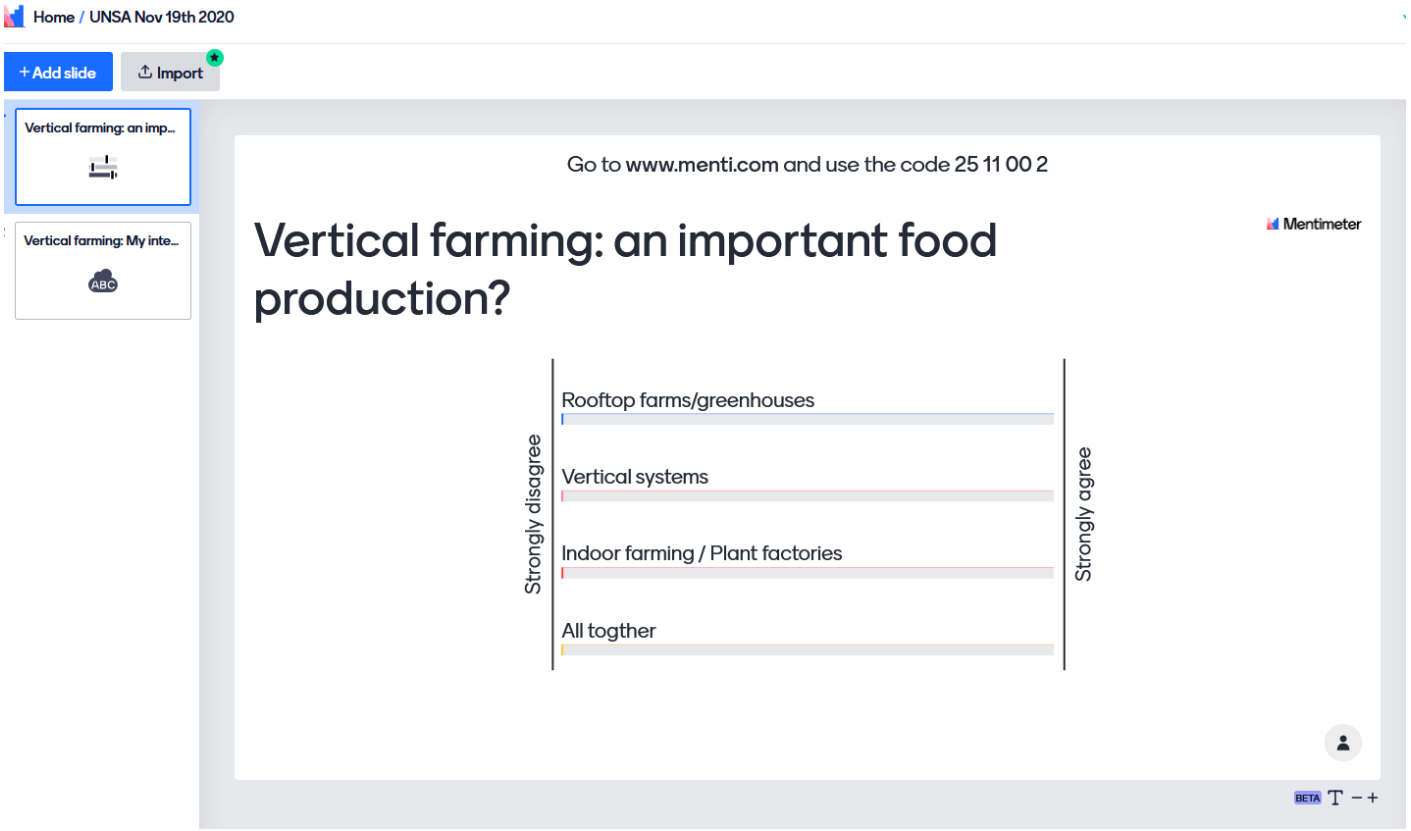
Differentiation and Diversification

- „Services“ (non-agricultural diversification „on-farm“)
  - Information and education (adults, kids, schools, …)
  - Vertical farming „tourism “ / Eventisation (sports, art, …)
  - Social offers (green care, care farming)
  - …

Vertical farming

Now it is your turn!

- It is your turn: *https://www.menti.com/6enckg7hny*



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Vertical farming

Business models / economic viability

- "Growers' ecological footprint needs to reduce by 50%, but controlled-environment agriculture (CEA) will only be a small part of it," he added. "We will need a toolkit of different systems including broad-scale farming."
- CEA "is fantastic at lettuce, arugula [rocket] and micro-greens, but they won't feed you-you still need protein, from plants, animals, fish or algae", he said
- CEA salads "are already yesterday's news", the technology offers plentiful opportunities elsewhere, in producing pharmaceuticals, fragrances, flavour chemicals, resins and other compounds.
- Speaking on the theme of "making vertical farming profitable", […] Robert Colangelo declared: "Urban farming is a bit of a myth." He explained: "The cost of real estate and labour in cities is high so it doesn't always make sense to operate there." He added: "Distribution is key to your business model.

iGrow

A Leader in The Localization of Agriculture

JUN 22

Has Vertical Farming Passed A Peak On The 'Hype Cycle'?

Has Vertical Farming Passed A Peak On The 'Hype Cycle'?

21 June 2018, by Gavin McEwan

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Vertical farming

Business models / economic viability

- Vertical farms can be set up almost anywhere, making it possible to grow crops in the middle of populous urban centres, meaning that it is possible for crops to reach consumers within minutes of harvest. This contrasts with traditional agriculture, where fresh produce can take weeks to reach consumers, losing freshness and increasing contamination risk along the way.
- Vertical farming has been the subject of a lot of hype in recent years, with supporters claiming it could revolutionise food production. Industry advocates, such as Columbia University Professor Dickson Despommier, have presented visions of a future world where fresh food is grown inside skyscrapers to feed giant, high-tech metropolises

Global Biotechnology Insights

Posted on June 3, 2020 by Dr Michael Dent with 2 Comments

How to Succeed in Vertical Farming

Vertical farming is an emerging technique within agriculture that involves growing crops indoors under controlled environmental conditions. By carefully tailoring the environment to the exact requirements of the crop, such through using LED lighting to produce the exact light spectrum needed for optimal photosynthesis, it is possible to obtain yields hundreds of times higher than traditional agriculture. Vertical farms can be set up almost anywhere, making it possible to grow crops in the middle of populous urban centres, meaning that it is possible for crops to reach consumers within minutes of harvest. This contrasts with traditional agriculture, where fresh produce can take weeks to reach consumers, losing freshness and increasing contamination risk along the way. The recent IDTechEx report,

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Vertical farming

Business models / economic viability

- However, despite this optimism, the industry does face some major challenges and the sector has more than its fair share of bankruptcies. […] David Rosenberg, Chief Executive of New Jersey based vertical farming outfit AeroFarms, recently said he wouldn't be surprised if 90% of the players in the industry went out of business within the next three years.
- Broadly, many vertical farms struggle for the same reasons. As well as costing a lot of money to set up, vertical farms can be very expensive to run, largely because they require continuously running artificial lighting and climate controls. This is compounded by high labour costs and logistical difficulties that often get more difficult as the vertical farm gets larger. This all makes it very difficult to compete on price with produce grown on conventional farms

Global Biotechnology Insights

Posted on June 3, 2020 by Dr Michael Dent with 2 Comments

How to Succeed in Vertical Farming

Vertical farming is an emerging technique within agriculture that involves growing crops indoors under controlled environmental conditions. By carefully tailoring the environment to the exact requirements of the crop, such through using LED lighting to produce the exact light spectrum needed for optimal photosynthesis, it is possible to obtain yields hundreds of times higher than traditional agriculture. Vertical farms can be set up almost anywhere, making it possible to grow crops in the middle of populous urban centres, meaning that it is possible for crops to reach consumers within minutes of harvest. This contrasts with traditional agriculture, where fresh produce can take weeks to reach consumers, losing freshness and increasing contamination risk along the way. The recent IDTechEx report,

Vertical farming

Overview

Introduction

Why is that a topic?

- Urbanisation
- „Food deserts“

Types of vertical farming

- Rooftop farms and rooftop greenhouses
- Vertical systems
- Indoor systems / plant factories

Business models

Excursus: Aquaponics

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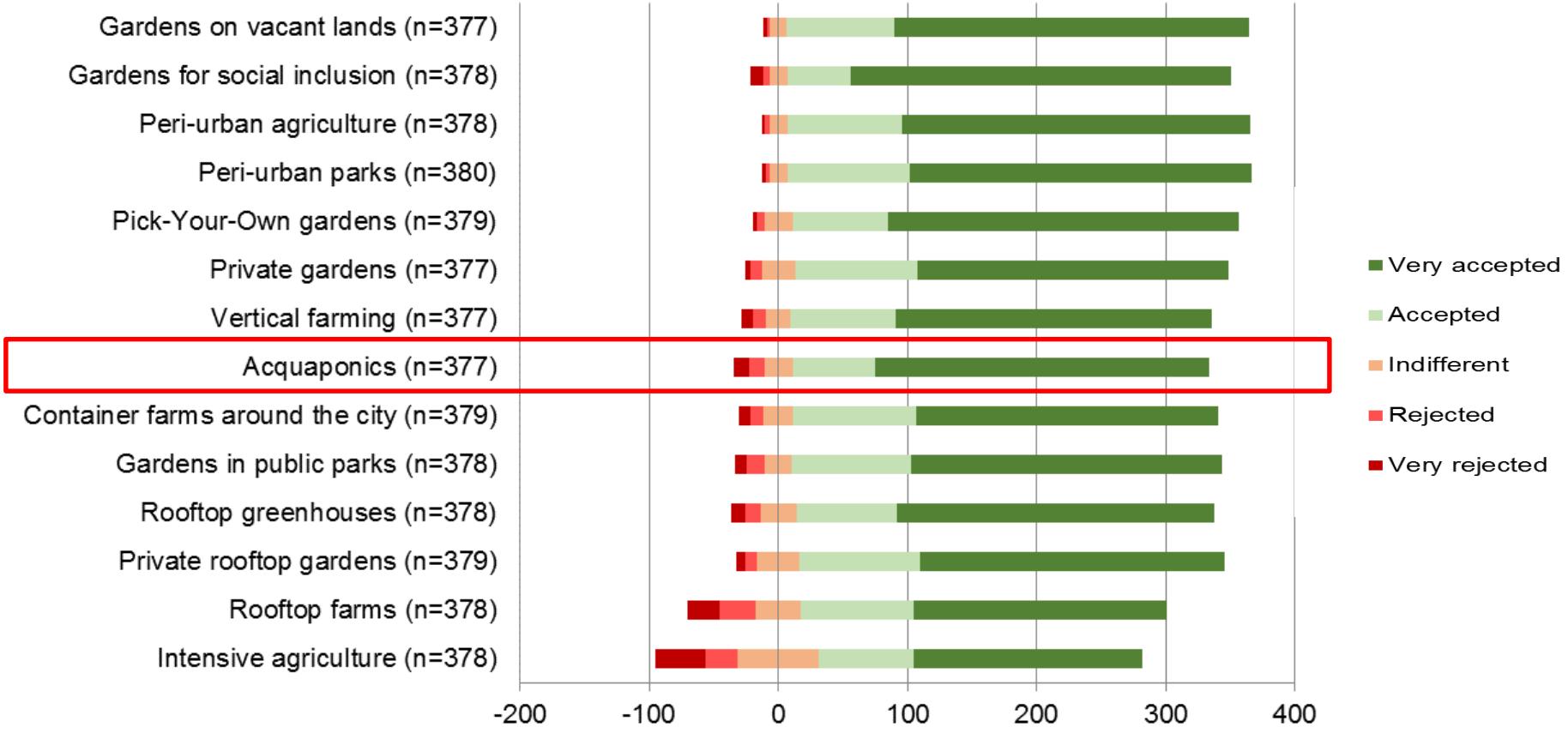
Vertical farming

Business models

Social acceptance of different types of urban agriculture

(Specht et al., 2016; Sanye-Mengual et al., 2017)



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2016 Time Square of UA in The Hague?

GREEN DESIGN | RENOVATIONS

Europe's Largest Urban Farm, 'Times Square of Urban Agriculture,' Opens in the Hague

Farmers can grow 50 tons of vegetables in a building designed by Rem Koolhaas's grandfather

By **Barbara Eldredge** | **@barbaraeldredge** | May 3, 2016, 12:58pm EDT

Source Global Construction Review

SHARE

The recently completed UF002 De Schilde, a 12,916-square-foot greenhouse sitting atop a former Philips factory in The Hague, can claim the title largest urban rooftop farm in Europe. Nicknamed the "Times Square of Urban Agriculture" because of its prime downtown location, De Schilde has the capacity to grow 45 tons of vegetables and raise 19 tons of fresh fish every year.

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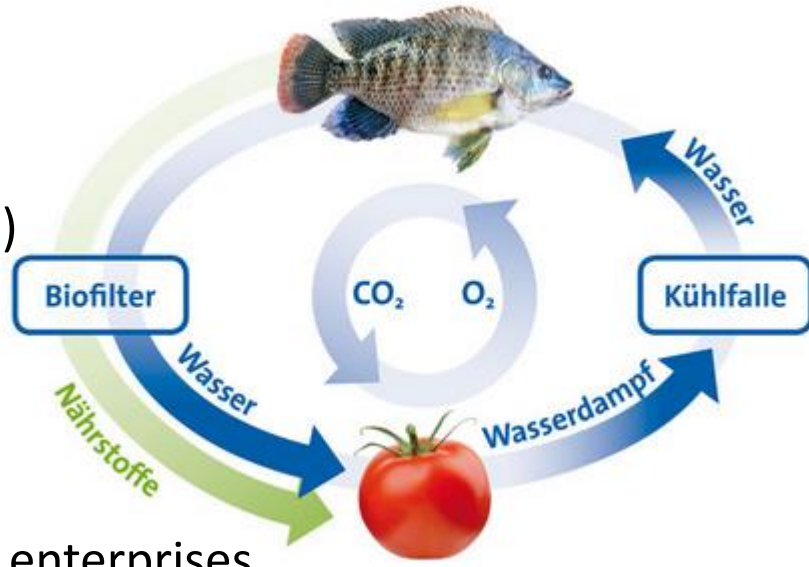
Aquaponik

- In Europe around 20 commercial aquaponics in use / under construction
- International state-of-the-art (*Love et al., 2015*)
  - > 250 respondents selling aquaponics-related (non-)food products/services (90% USA, CDN, AUS)
  - more a hobby than successful commercial enterprises
  - Aquaponics as a profitable operation (31% of respondents)
- US study
  - based on US „aquaponics census“ (71 aquaponics farms)
  - Only 1/10 with reasonable economic turnovers



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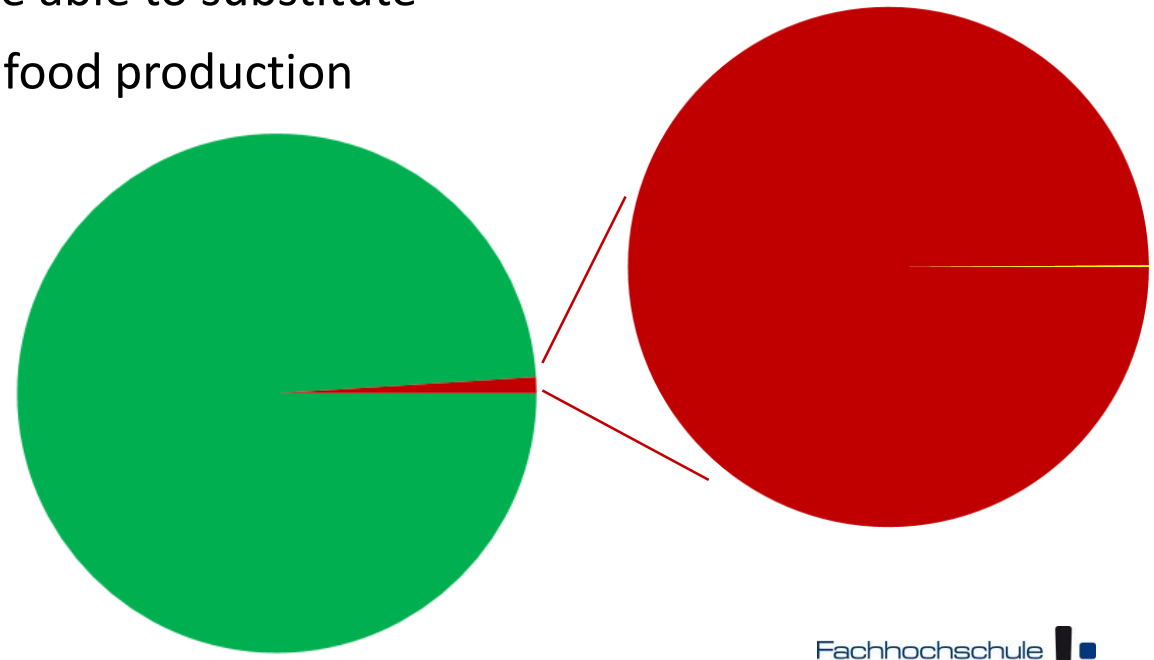
Aquaponik

The Central European perspective

- German Agricultural Area: >18 mio ha
  - 230,000 ha for horticulture: 1.3% of German AA
  - only around 1,000 ha under glass production (0,005% of German AA)
- Aquaponics will only be able to substitute

  a small fraction of our food production



Aquaponik

Profitability calculations

- calculations for three sizes:

	„micro“	*„small“*	*„production“*
Aquaculture:	3 m³	10 m³	300 m³
Hydroculture:	60 m²	200 m²	5,500 m²

- primary data from the system at Department of Agriculture in Soest
- assumptions, like wages, losses, real estate and heating costs, marketing, …
- head lettuce (2.50, 1.50 €/kg)/European catfish *(Silurus glanis),* 17.50 €/kg

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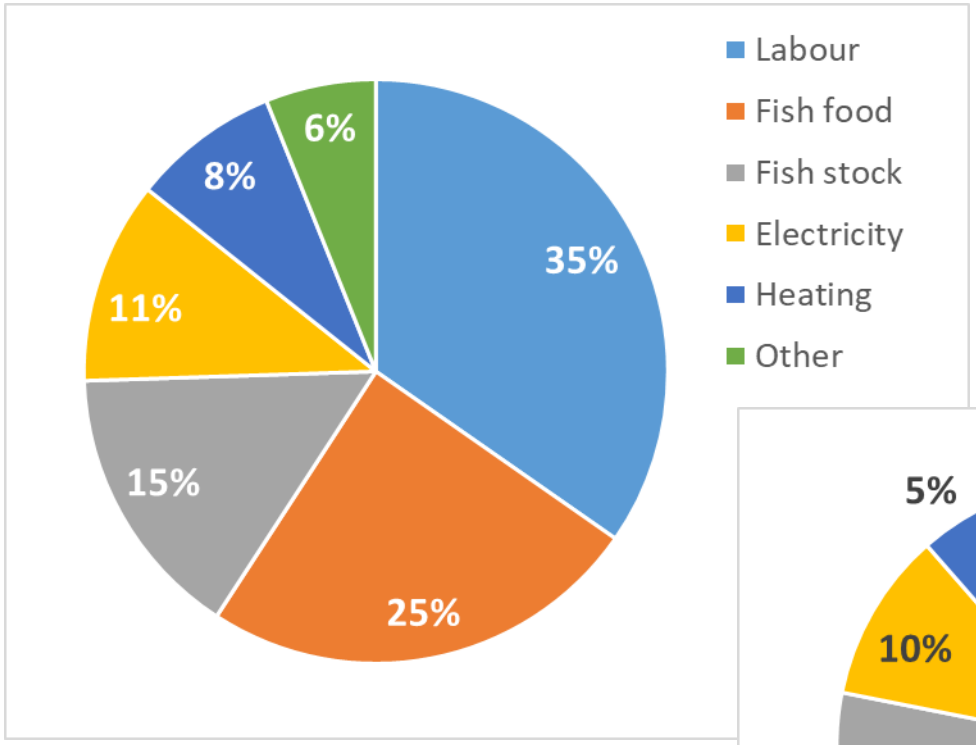
Profitability calculations

Cost performance accounting	Unit	micro	small	production
Contribution margin aquaculture	€/a	-4,173	-2,566	114,862
Contribution margin hydroculture	€/a	691	13,827	541,087
Sum contribution margins (= turnover – variable costs without labour costs)	**€/a**	**-3,483**	**11,260**	**655,948**
Labour costs aquaculture	€/a	3,705	8,198	45,000
Labour costs hydroculture	€/a	3,148	8,395	179,443
Sum labour costs	**€/a**	**6,853**	**16,593**	**224,443**
Real Estate costs / Overhead		*n.a.*	*n.a.*	*n.a.*
Depreciation (building, system 20 years)	€/a	7,573	15,229	185.269
Interest rate 0.02	€/a	1,515	3,046	37,054
Cost performance accounting	**€/a**	**-19,424**	**-23,607**	**209,183**

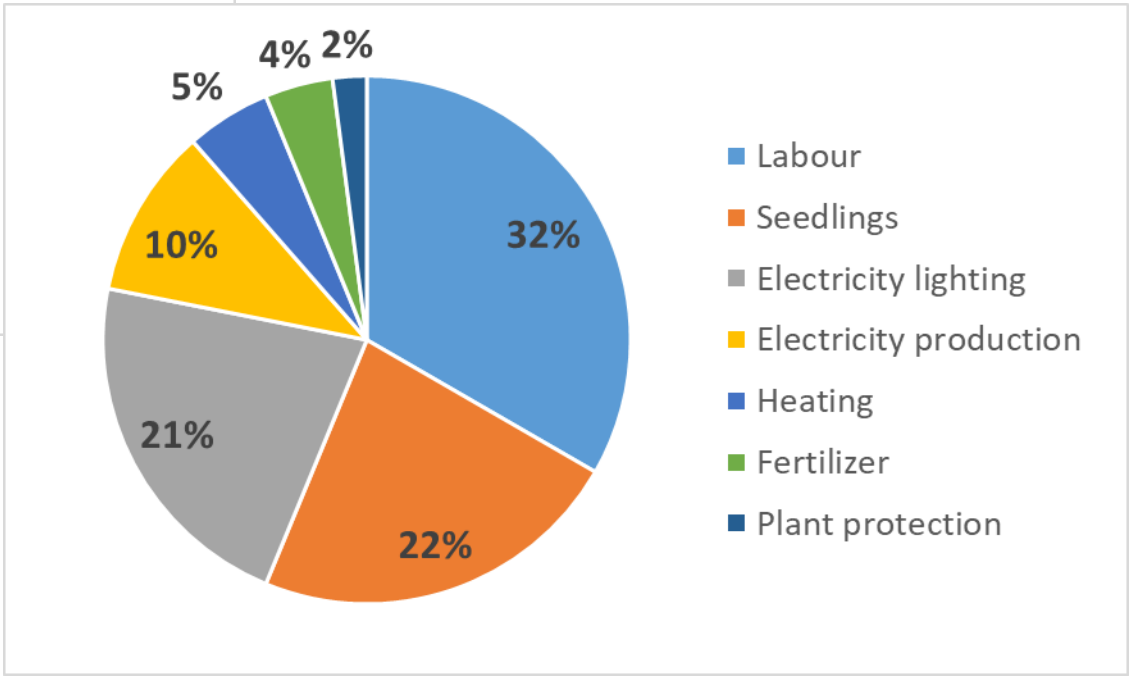
Aquaponik

Variable costs incl. labour costs



Aquaculture

Hydroculture



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„Vertical farming“ UNSA November 19th 2020
60, Bernd Pölling, FH Südwestfalen

2018

Dutch rooftop farm declared bankrupt

When being built it was the largest rooftop farm in Europe. Now the Dutch rooftop farm UF De Schilde has been declared bankrupt. The farm, realised on top of an empty 1950s office block, hasn't been able to compete with the nearby Westland region.

It's 1200 m², fully decked out in double glazing, and the cultivation of lettuce, tomatoes and microgreens in this greenhouse is combined with fish farming. That's how we started the article about the Dutch rooftop farm De Schilde when construction was finalized in 2016. The project was realized by collaboration between UrbanFarmers AG, a private investor and Stimuleringsfonds Volkshuisvesting (SVn: the Dutch Municipalities' Housing Development Fund).

Back then, the plan was met with great skepticism: the yields of the project would not compete at all with the greenhouses in Westland, only a couple of kilometres nearby.

Aquaponik: ECF Farmsystems, Berlin

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Wir geben Impulse

„Vertical farming“
…more than a hype?

Sarajevo University

November 19th, 2020, Online - Dr. Bernd Pölling

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Co-funded by the Erasmus+ Programme of the European Union

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„Vertical farming“

– more than a hype?

Project number: 586304-EPP-1-2017-1-BA-EPPKA2-CBHE-JP “This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein”

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