FOOD & BIOBASED RESEARCH
WAGENINGEN UR

Opportunities for hydro- and aquaponics in Egypt

Dr. J.M. Soethoudt
J. Hendricks, MSc
N. Waldhauer, MSc

Report 1635

Colophon

Title	Opportunities hydro- and aquaponics in Egypt
Author(s)	Dr. J.M. Soethoudt J. Hendricks, MSc N. Waldhauer, MSc
Number	1635
ISBN-number	978-94-6257-712-1
Date of publication	March 2016
Version	Final
Confidentiality	No
OPD code	OPD code
Approved by	Nicole Koenderink
Review	Internal
Name reviewer	Nicole Koenderink
Sponsor	Embassy of the Kingdom of the Netherlands in Cairo
Client	Embassy of the Kingdom of the Netherlands in Cairo

Wageningen UR Food & Biobased Research
P.O. Box 17
NL-6700 AA Wageningen
Tel: +31 (0)317 480 084
E-mail: info.fbr@wur.nl
Internet: www.wageningenur.nl/en/fbr

Content

1 Introduction

1.1 Background

Worldwide we observe the parallel trends of a significantly increasing world population and of strong urbanization resulting in changes in the consumption pattern for food, namely increasing demand for fruit and vegetables, meat and fish, milk products, fruit juices, soft drinks, beer, wine and spirits as well as higher standards regarding food safety, freshness, taste and fashion in food (UNFPA 2008). These developments can also be observed in Egypt with the explosive growth of the total population and significant enlargements of urban centers and in parallel growing demand for fresh food of high quality and taste (Dawoud 2013). Current production will not be able to satisfy these changing consumption patterns, neither in the volume and type of the products nor with regards to freshness, quality, convenience, choice and safety. Food security is thus under increasing pressure in Egypt and in parallel opportunities arise in the market for new concepts and business models. First local initiatives answer to these demands, especially by catering to the upper class of the Egyptian society who has both awareness of the problem and enough wealth to pay for more expensive products. However, these developments are too slow to solve the problem in the near future and thus the problem is only increasing.

The Netherlands on the other hand has significant experience and expertise worldwide in the production of fresh fruit and vegetables and on how to transform this production into successful business models. Therefore the agricultural office of the Dutch Embassy in Egypt in close cooperation with DGAGRO of the Dutch Ministry of Economic Affairs has been developing a program on agrologistics in Egypt since June 2012. The program is targeting the improvement of food security in Egypt in general and the reduction of post-harvest losses in particular as major gains in securing food supply of the population are expected in this area. One of its pillars aims at implementing pilot projects applying Dutch technology and systems with a combined Dutch-Egyptian consortium in a local setting and thus contributing to solving the above mentioned challenges Egypt is facing. One such technology is hydroponics production of leafy vegetables, particularly interesting in the context of the current and future water scarcity in Egypt.

1.2 Objectives

A recent market study (Nina Waldhauer 2014) showed that the main production constraints for hydroponics farming in Egypt are mainly the consequences of small scale hydroponic production and limited experience with these production systems. The goal of this study is thus to define and setup a supply chain concept for large scale professional hydroponics production for the local market in Egypt. The study was done by researchers of Wageningen UR Food & Biobased Research (FBR) as well as HortiAlliance during November and December 2015, commissioned and financed by the Agricultural Office of the Embassy of the Kingdom of the Netherlands in Cairo.

Important questions that need to be answered for setting up a supply chain concept and related business case are:

- Which hydroponics systems are currently or could potentially be used in Egypt and what are the advantages and disadvantages of these systems?
- What does the market for hydroponics in Egypt currently look like and what is the expected market potential?
- What are consumer preferences and which elements are the main drivers for purchasing vegetables?
- What are the most interesting products and through which market channel should they be sold?
- How does a potential business case look like?

The researchers have conducted an objective and independent study in order to answers to these questions. The findings and resulting business case are described in this report. The respective methodology is explained per section in the following chapters.

As an overall result of the study it can be concluded that an interesting business case for hydroponics production can be set up taking into account:

- High-end customers should be the target clients, being strongly incentivized by the quality of the product.
- Given limited current productivity of the start-ups, small retailers should be targeted.
- Tomatoes are a very interesting product due to them being consumed in high volumes in Egypt.

It is to be noted that the largest part of the findings of this report is based on stakeholder interviews as well as a consumer focus group organized during a field mission in November 2015. The wider applicability of the results is therefore limited.

The key target group of the report and the findings are parties that are interested in using the opportunity that the Egyptian market is currently offering for entering this relatively new market segment. These are mainly Egyptian hydroponics growers (current and potential future), market players such as retailers, restaurants and hotels, potential investors as well as Dutch supplier of input materials. Further, this report is also targeting the wider interested public as the findings could offer a starting point for similar researches in other emerging counties that face a similar situation as Egypt.

1.3 Report outline

In chapter 2 the drivers for this research are described and confirmed based on literature and interviews on the spot. In this study, focus is on hydroponics and aquaponics, which are water saving non-standard production technologies. The corresponding production systems are described in chapter 3 based on expert knowledge of one of the authors. The current situation of

hydro- and aquaponics production in Egypt is based on interviews and presented in the second part of chapter 3. The retail market and vegetable consumption are elaborated upon in chapter 4. Exploratory research is applied by interviewing stakeholders such as current and potential growers, retail and restaurants. With respect to consumers, a focus group was organized among high-end consumers in Cairo. It has to be stressed that about 15 interviews were carried out and hence the results should be considered in that context of representativeness. In chapter 5 an indicative business case is presented to follow up this research. The last chapter covers the conclusions of the study.

2 Background and motivation

In regions where urbanization increases, in many cases a shift to higher value food is taking place, from staple and low value vegetables (onions, cabbage, potatoes) to higher value vegetables (tomato, peppers) and animal products. This general trend in combination with the population growth in Egypt and the strong dependency on food imports asks for measures to support national production of these food products. Different from many other (slowly) emerging economies, Egypt has to deal with the issue of water scarcity, requiring solutions taking this problem into account. One of the options is hydroponic production. To stress the acuteness of the water scarcity and the demand for adequate responsiveness to it, some background on water scarcity is given.

2.1 Water scarcity

Because of its dependency on water from the Nile that flows in from other countries, Egypt exhibits the highest dependency ratio: 97 percent of total renewable water resources originate outside its borders. This most important water source of the Nile Basin is expected to face significant water shortages in the order of 20 and 30 km^3 per year in 2020-2030 and 2040-2050 respectively[1].

Large-scale water management problems are already apparent: aquifers are over-pumped, water quality is deteriorating, and water supply and irrigation services are often rationed—with negative consequences for human health, agricultural productivity, and the environment[2]. In the Southern and Eastern Mediterranean Countries (SEMCs), water scarcity is characterized by low per capita water availability, low level and uneven distribution of rainfall, frequent recurrence of droughts, and high human pressure on existing water resources.

There lies an ocean of water underneath the Egyptian's western desert[3]. Egypt has access to a total of 375.000 km3 of water, deeply locked away in a layer of sandstone at a depth of 1.000 meters. It's adequate to keep the Nile flowing for an additional 500 years. This ocean of water (also known as the Nubian Aquifer) was discovered by the IAEA (International Atomic Energy Agency) in 2007. The Egyptian government has drafted plans to develop an area of 1,5 million feddans (630.00 Ha.) of farm land to be irrigated from this aquifer this past year. To access the aquifer the government plans to spend 600 million USD to drill 5.000 wells. In October 2015, 600 wells have been drilled stated an official of the irrigation ministry[4]. The water might be able to sustain a few decades of large scale agriculture, but eventually the water would run out if wholesale water exploitation is continued.

[1] www.fao.org/nr/water/aquastat
[2] www.iaea.org/water
[3] www.iaea.org/water
[4] www.thenational.ae

The farming system in the Nile delta is very labor intensive and is different from desert farming. Usually, the desert farms are large integrated, international companies which have access to technology and capital to achieve economies of scale, but who will never be big employers.

Given population growth estimates, a decline in per capita availability of water is expected and water shortages across the Middle East and North Africa (MENA) region will be a key challenge in the near future. Overall, per capita freshwater availability is projected to fall by more than 50 percent by 2050 in the region. Still, 80 percent of that shortage will be attributable to a steep increase in demand owing to population growth and fast economic development (including the rising demand of a growing and wealthier middle-class, with different dietary habits shifting from vegetable proteins and minerals to increased processed foods, sugars, fats, and animal products), and about 20 percent may be attributed to climate change[5]. In Egypt, with a national population expected to grow from around 80 million today to around 97 million in 2025 (UN Population data), current per capita water availability is projected to be reduced by 40 percent to reach around 500 m^3 per year by 2025[6].

2.2 Potential of hydroponic food in Egypt

In Egypt, production of agricultural and horticultural crops is very fragmented. In this regard, Egypt is not much different from the surrounding markets in the MENA region. For obvious reasons the vast majority of the growers are located in the Nile Valley and the Nile Delta: this is the most fertile area with the optimal micro climatic conditions, fertile soils and access to water. The threats to these areas are many, amongst which:

- over-extraction of water;
- increasing pollution levels of surface water;
- use of agricultural land for industrial or housing purposes.

To identify the current status in volume and assortment and anticipated technical and economic developments of HAP in Egypt open interviews with the 5 largest vertically integrated farms, 3 retailers, 1 industry association and 3 local consultants were conducted. The farms are diversified operations which produce and process an array of crops such as potato, onion, cabbage, carrot, melon, tomato, lettuce (mainly cos and iceberg) but also orchard crops like banana, citrus, almond, date. More recently the segment of soft fruits is becoming of increasing importance. All of these farms have direct international market access to retailers in Europe, the Middle East and Russia. Generally, the local wholesale channel is equally important as the export markets.

The open interviews were carried out in the supply chain with producers of agricultural products and retailers. The purpose of these interviews was to investigate the market trend of lettuce in Egypt and the potential of HAP. These interviewees indicate that the market for leafy vegetables

[5] *http://data.worldbank.org/country/egypt-arab-republic*
[6] *www.fao.org/nr/water/aquastat*

will continue to grow, but soon be saturated due to the relatively small addressable population in the local market. It is not expected that exports will develop to a significant share of Egypt's production base, if any exports will arise at all. The current production base of lettuces in Egypt is limited to 4,500 hectares[7] and consists mainly of the Iceberg type which is grown as a row-crop and which is mainly sold to the local fastfood industry.

However, the same interviews revealed a great interest to develop a production base for hydroponic tomato. The requirements for such proposition are simply confined to:

- Year-round availability
- Consistent quality
- Consistent volumes
- Food safety (perceived attribute of a product grown on water)

Anecdotal references of a local agronomist (Dr. Hosni Abdelbaky) indicate that especially tomato production is a major absorber of water use. Egypt currently uses 220.000 hectares for tomato production on which (with the current systems) a yield of only 4 kg per m^2 is achieved. The water use per kg is 250-300 litres. With a recirculation system this could be reduced to 10 litres per kg and a production of 20-25 kg per m^2 is considered to be feasible.

[7] *www.faostat.org*

3 Hydroponic production[8]

To find a solution which can address the challenges and opportunities in a relatively short time span, this research attempts to define the minimal viable system to achieve water smart production of key-crops in Egypt. As an outline for this research we have taken components of commonly available technology in horticulture and one of Egypt's most water-intensive crops: tomato.

This approach will help define an economical and technically viable system in a very short time span. Timing is crucial due to fast developing government policies and programs. Development of land reclamation and design of systems has already started within various execution bodies. If private companies are to take advantage of this large development program, they should be aligned to the overarching program objectives.

At first sight, water is the most obvious key constraint in the near future. Hence we will assess commercially available technology (common in horticulture) as part of the solution to decrease water use in agriculture. This implies adapting systems in the field of irrigation, fertigation, desalination and disinfection. All of which are applied in so-called hydroponic systems. The fundamental of such hydroponic system is that all water in the system is continuously re-circulated between the storage reservoir, mixing tanks (for fertigation and disinfection) and the plants. This eliminates all evapotranspiration in the soil and drainage of water into the ground.

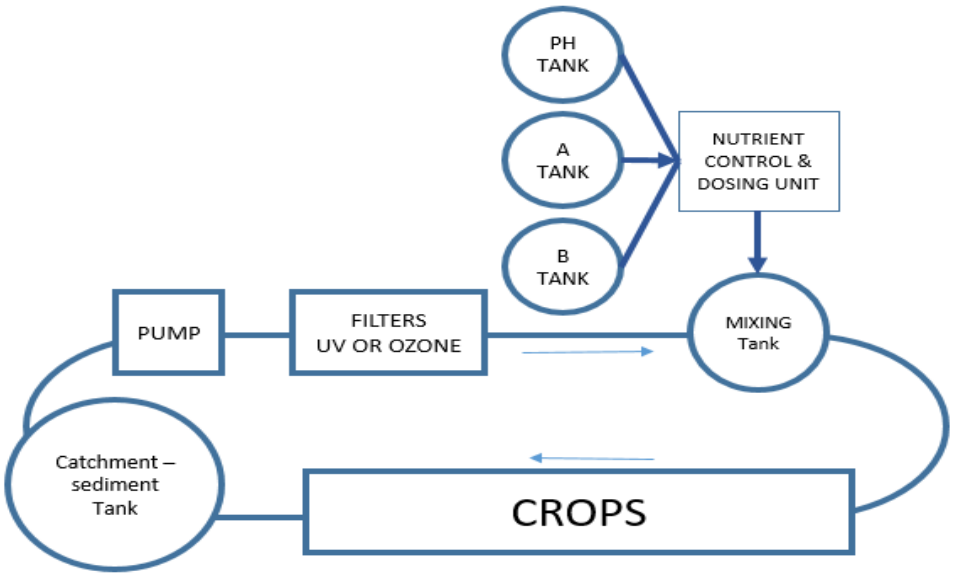


Figure 1: Schematic overview of Hydroponic system

[8] *The following section is based on expert knowledge of Joep Hendricks*

3.1 Definition of Hydroponics

The definitions of hydroponics are many. It is a catch-all term in which a great variation of technical components, physics, and physiological principles are combined. The following systems are currently used by growers in Egypt, or are potential candidates for increased application:

3.1.1 Deep Water - Static solution culture

Plants are grown in reservoirs with water and nutrient solution. The solution is usually gently aerated but may be un-aerated. If un-aerated, the solution level is kept low enough that enough roots are above the solution so they get adequate oxygen. The plants are held in position through a hole in the top covering. The nutrient solution is changed or altered on regular intervals or when the concentration drops below a certain level as determined with an electrical conductivity (EC) meter. Whenever the solution is depleted below a certain level, either water or fresh nutrient solution is added.

In raft solution culture, plants are placed in a sheet of buoyant plastic that is floated on the surface of the nutrient solution. That way the solution level never drops below the roots.

Figure 2: Deep Water Hydroponic Production where plants "float"on Styrofoam rafts in a ststic solution. (credits Bustan Aquaponics)

3.1.2 NFT - Continuous-flow solution culture

In continuous-flow solution culture, the nutrient solution constantly flows past the roots. It is much easier to automate than the static solution culture because sampling and adjustments to the temperature and nutrient concentrations can be made in a large storage tank that has potential to serve thousands of plants. A popular variation is the nutrient film technique or NFT, whereby a very shallow stream of water containing all the dissolved nutrients required for plant growth is recirculated past the bare roots of the

Figure 3: NFT – Continuous Flow production (credits Egypt hydro farm)

plants in a thick root mat, which develops in the bottom of the channel and has an upper surface that, although moist, is in the air. Subsequent to this, an abundant supply of oxygen is provided to the roots of the plants. A properly designed NFT system is based on using the right channel slope, the right flow rate, and the right channel length. The main advantage of the NFT system over other forms of hydroponics is that the plant roots are exposed to adequate supplies of water, oxygen, and nutrients. In all other forms of production, there is a conflict between the supply of these requirements, since excessive or deficient amounts of one results in an imbalance of one or both of the others. The result of these advantages is that higher yields of high-quality produce are obtained over an extended period of cropping. A downside of NFT is that it has very little buffering against interruptions in the flow, e.g., power outages.

As a general guide, flow rates for each gully should be 1 litre per minute. At planting, rates may be half this and the upper limit of 2 L/min appears about the maximum. Flow rates beyond these extremes are often associated with nutritional problems. Depressed growth rates of many crops have been observed when channels exceed 12 metres in length. On rapidly growing crops, tests have indicated that, while oxygen levels remain adequate, nitrogen may be depleted over the length of the gully. As a consequence, channel length should not exceed 10–15 metres. In situations where this is not possible, the reductions in growth can be eliminated by placing another nutrient feed halfway along the gully and halving the flow rates through each outlet.

Figure 4: lettuce harvest on Egypt hydro farm. Amr. Bassiouny (right) (credits Egypt hydro farm)

3.1.3 Ebb and flow or flood and drain sub-irrigation

The fundamental principle of hydroponics relies on fertilized and aerated water which provides both nutrition and oxygen to a plant's root zone. Ebb and flow is a form of hydroponics that is known for its simplicity, reliability of operation and low initial investment cost. Pots or slabs are filled with an inert medium which does not function like soil or contribute nutrition to the plants but which anchors the roots and functions as a temporary reserve of water and solvent mineral nutrients. The hydroponic solution alternately floods the system and is allowed to ebb away. Ebb and flow utilizes the fact that the solution is not left in

Figure 5: Hydroponic production on rockwool, credits Joep Hendricks

constant contact with the roots of plants, to avoid the need for oxygenating or chilling of the solution. Instead it relies on characteristics of root function to provide passive oxygenation at a high level which tends to suppress pathogen growth.

Under this system a water-tight growing bed, containing growing media like coco peat, rock wool, clean gravel or coarse sand as the rooting medium, is periodically flooded for a short period (5 to 10 minutes) with a nutrient solution pumped from a supply tank. By placing a tank at a lower level than the growing bed, the nutrient solution can drain back by gravity and the drain water can be re-used. Because it is a "closed" system, the re-circulated nutrient solution will require reconstitution, filtering, and sterilization (UV radiation). Usually the rooting medium has a single use, but it may be reused provided that it is washed to remove root debris and accumulated precipitates as well as sterilization (steam).

Figure 6: Hydroponic production on coco Peat, credits Jiffy Growbags South Africa

Nutrient solutions must usually be below the temperature at which pathogen growth can begin, yet not so cool that root activity is suppressed. Active aeration of the fertilizer solution is common, since root systems themselves remove oxygen, creating conditions which also can promote pathogenic bacteria and water-borne moulds.

Ebb and flow systems come on according to the water-holding capacity of the medium in which the roots sit. Highly water-retentive media can require watering only once a day, while others require two to as many as six floodings, with each "flood" stage only lasting a few minutes. The time it takes to flood the roots is not a critical parameter, which means that pumps are often moderate in capacity and can be small. Gravity acts as drain pump, and aeration is accomplished through thin-filming and positive displacement of air as it is forced out of the root zone by water.

3.2 Hydroponic systems in Egypt

Over the past decade many trials with a variety of systems have been done in a variety of scales and stakeholders. Partnerships between Dutch and Egyptian companies have been set-up and trials in crops like capsicum are currently on-going (AllGreen and Bio Egypt with Koppert Bio and Hortimax) and focus mainly on an uplift of the technology and reveal commercial opportunities for Dutch technology suppliers.

As described afore, the systems which form the current installed base of Egypt are of a different league when compared to the Dutch standards, yet they are reasonably effective for the purpose they were designed for. There is room for system improvements and cultivation optimisation, but

eventually the drivers to implement such improvements come from either one or multiple of these:

- Market demand (retailer's specs)
- Economic efficiency
- Government policies and arrangements
- Natural influencers such as climatic conditions or
- Availability and access to resources as water and energy, labour.

In the regard of the more extensive systems and the water efficient hydroponic systems, the market is still in an embryonic stage and hence the production base is very small. The research only found three commercial growers of hydroponic systems and one grower on an Aquaponic (hydroponics, extended with Recirculating Aquasystems, RAS, fish tanks). All of these growers currently focus on growing short-cycle leafy crops like lettuces and herbs. Trials with fruit crops have been conducted on the deep-water hydroponic system, but had an unsuccessful outcome. Visits to these locations brought to light that the current hydroponics systems are in three cases gutter production with a continuous water flow (Nutrient Film Technology, NFT) systems and in one case a deep-water basin with floaters of Styrofoam with a near-static water flow.

Farm	Crops	Total size 2016 est.	System
1	Leafy Greens	0,8 ha	NFT gutters
2	Leafy Greens, Herbs	0,6 ha	Deep water
3	Leafy Greens, Herbs	1,0 ha	gutters
4	Leafy Greens	0,5 ha	gutters

Table 1: Estimated production of hydroponic leafy greens in 2016 in Egypt (Interviews with Egyptian growers, November 2015)

These hydroponic systems generally work very well for the leafy crops, but that market seems to be relatively small in Egypt. Lettuces are not a common ingredient in the Arabic menu, so the market is limited to a population of consumers orientated on a global cuisine, and a food service channel addressing the demand of local restaurants and hotels.

4 The Hydroponics market

Obviously the market can be divided in the potential and installed base for 1) the systems and 2) the local consumer demand. In this research we have addressed both due to the fundamental assumption that there is a big gap between the current local product propositions and the current and developing consumer demand. This assumption is based on the fast relative growth of the formal retail share of which important drivers are:

- Emerging middle class with more specific demands;
- Convenience one-stop-shopping at formal retail outlets, such as hypermarkets;
- Increasing ticket value of food expenditures;
- Increased awareness for health, wellbeing and food safety.

This research addresses the economics of a hydroponics system. This is influenced by the potential uplift in production and saving of water and also about the potential income increase as a result of a price premium for a safe, healthy proposition of vegetables.

4.1 Retail

One of the potential markets for Hydroponics and Aquaponics Production, HAP, is retail, although the characteristics of the HAP and the retail need to find a match in the sense of assortment, retail profile and scale. First the retail landscape is described, followed by considerations about the relation between HAP and retail.

4.1.1 Retail in Egypt

In all emerging economies retail is increasing its market share in the food sales. In Egypt this is happening as well albeit slowly. This is show in Table 2 (Orestes Vasquez 2015).

EGP bn, retail value excl sales tax	2009	2010	2011	2012	2013	2014
Modern Grocery Retailers	**25.0**	**29.0**	**32.3**	**36.9**	**41.5**	**46.3**
- Convenience Stores	0.7	0.8	0.8	0.9	1.2	1.4
- Discounters	-	-	-	-	-	-
- Forecourt Retailers	1.9	2.1	2.2	2.3	2.4	2.6
- Hypermarkets	2.1	2.7	3.9	4.7	5.0	5.7
- Supermarkets	20.4	23.5	25.4	29.0	32.8	36.6
Traditional Grocery Retailers	**113.9**	**123.3**	**128.1**	**135.0**	**144.8**	**156.5**
- Food/Drink/Tobacco Specialists	60.5	66.5	67.5	70.4	75.8	82.6
- Independent Small Grocers	23.4	26.0	29.2	33.0	36.9	41.1
- Other Grocery Retailers	30.0	30.8	31.4	31.7	32.0	32.8
TOTAL Grocery Retailers	**138.9**	**152.3**	**160.4**	**171.9**	**186.2**	**202.8**

Table 2: Retail value in EGP bn excl. sales tax in Egypt retail over the years 2009-2014

In 2009 the retail market share was 18% against 23% in 2014. Hypermarkets are not centralized in the cities and sales will likely continue to grow, however, many Egyptians are reluctant to spend money for transport to these malls. They view traditional grocery retailers as more affordable and convenient, since they always can be found nearby. In high-density urban areas it is easier to start small shops and hence convenience stores increased their market share significantly providing the nearby service.
Internet retailing is not widely used. Metro and Ragab Sons have pioneered but without much success. Several retailers have a home delivery service (by telephone). Only Gourmet has online shopping at the moment.

One of the relevant characteristics of retail is the size of the retail brand. The market share of the largest brands are listed in Table 3:

% retail value rsp excl sales tax	Company	2011	2012	2013	2014
Metro	Mansour Mfg & Distribution (MMD)	2.7	2.7	2.5	3.0
Ragab Sons	Ragab Sons for Trade & Distribution	0.9	1.8	2.4	2.4
Carrefour	Majid Al Futtain Hypermarkets LLC	1.3	1.5	1.5	1.7
Kheer Zaman	Mansour Mfg & Distribution (MMD)	0.7	0.8	0.9	0.8
Spinneys	Spinneys Egypt Ltd	0.6	0.7	0.7	0.7
Zahran	Zahran Group	0.3	0.5	0.6	0.6
Carrefour Market	Majid Al Futtain Hypermarkets LLC	0.2	0.4	0.5	0.6
Al Mahmal	Al Mahmal Co	0.2	0.3	0.4	0.4
Hyper1	Al Hawary Co	0.5	0.5	0.4	0.4
Fathalla	Gomla Marke Co	0.3	0.3	0.4	0.4
Seoudi	Seoudi Co	0.4	0.4	0.4	0.4
Awlad Ghanem	Al Marwa For Trading & Distribution Co	0.2	0.2	0.3	0.3
Alfa Market	Alfa Market SAE	0.2	0.2	0.2	0.2
Mobil Market	Exxon Mobil Corp	0.1	0.1	0.1	0.1
La Poire	International Co for Sweets Production	0.1	0.1	0.1	0.1
Esso Snack & Shop	Exxon Mobil Corp	0.1	0.1	0.1	0.1
Oscar	Oscar Supermarket	0.1	0.1	0.1	0.1
Abou Zekry	Abou Zewkry SAE	0.1	0.1	0.1	0.1
Royal House	Royal House Supermarket	0.1	0.1	0.1	0.1
Abba	Abbanoub Inter Trade Co	0.1	0.1	0.1	0.1
Others	Others	90.8	89.2	88.0	87.3
TOTAL Grocery Retailers		100,0	100,0	100,0	100,0

Table 3: Market share development of main retail brands in Egypt (Orestes Vasquez 2015)

The total sales being 202,8 bn EGP implies Metro sales in 2014 to be 3% of 202,8 bn EGP is about 730 million €. For comparison the Albert Heijn retail sales in the Netherlands excl. tax was 32,8 billion € in 2014 and Tesco sales incl. tax was about 100 billion € (of which 2/3 in the UK).

4.1.2 Hydro- and aquaponics in retail

To enter the retail market products have to fit into the characteristics of the retailer at hand. As mentioned earlier the main issues are scale, retail profile (consumer type, price level, quality) and assortment.

To illustrate the relevance of these issues data from Hyper1 are given as an example. About 10-15 trucks of fruits and vegetables arrive every day, and they sell 1500-2000 capucha salads (iceberg lettuce) per day.

Figure 7: Fruit and vegetables section in Hyper1 in Cairo, credits Han Soethoudt

Hyper1 has about 15.000 customers per day and the profile is linked to the slogan 'value for money'. The price is not high and they mainly serve B- and C-class consumers. The two HAP farms do not fit into the requirements of Hyper1. The price is too high for the consumers entering Hyper1 and the scale is difficult to achieve, especially since one of the 3 values of Hyper1 is consistency of supply.

As a consequence distribution of HAP products in retail is (as far as we know until November 2015) restricted to small retailers, namely Gourmet and Sunny market[9]. Gourmet has 5 shops in Cairo and 1 in Alexandria[10] and Sunny has only 1 outlet, which is in Cairo. They are too small to be listed in Table 3. Both retailers are selling products from both HAP-farms (Egyptian Hydrofarms and Bustan Aquaponics). Gourmet (part of AM Foods) is a well-known retail brand for A-class consumers. The price level and quality is high. Gourmet is selling 21 HAP products at

[9] *See picture at front page taken in Sunny market at 9-11-2015*
[10] *http://www.gourmetegypt.com/about-us , viewed at 3-12-2015*

the moment[11] (see Appendix B). The available assortment from these two producers is restricted to leafy vegetables (lettuce, kale, endive) and herbs.

Sunny supermarket was waiting for HAP tomato for sale, but it was not delivered yet. From the interview with Bustan Aquaponics it was clear that there are some technical difficulties to grow tomatoes in the same aquaponics system as the green leafy vegetables. So there is not a good match between on the one hand the market demand with respect to the assortment and on the other hand the technical possibilities in production.

Summarizing on the main issues for HAP sales we have:

a) Volume: the throughput in hypermarkets like Carrefour and HyperOne1 are far too high in relation to the volumes produced on the HAP farms. Small retailers should be targeted first.
b) Price: the B-to-B price for HAP is already relatively high[12]. Retail typically operates on 50-100% gross margin and therefore HAP may be beyond the price range of most people. As an example the romaine lettuce in HyperOne1 is 1.5 EGP/piece, whereas the one in Sunny market is 12 EGP/piece. Retailers with A-class consumers in their profile currently are the only potential outlets.
c) Products: the current HAP assortment does not match the vegetables mainly consumed by Egyptians. Tomato, onions, squash, eggplant and cucumber are the most relevant vegetables and the potential retailer is asking for these products produced in a hydro- or aquaponic way.

4.2 Out of home

The out of home market is very fragmented and diverse. Subsectors are catering (business, hospitals, inflight), railway/airport outlets, bars, restaurants, hotels, resorts, prisons, army, fast food, leisure, etc. Except for some large chains of hotels, resorts and fast food companies the scale of these stakeholders is smaller than the retail companies in Table 3. From that point of view the potential for new clients is typically in this sector.
Moreover, in many cases like restaurants and hotels, in the out of home business there is no extra margin since the out of home stakeholder is the last link in the chain and the purchasing price for e.g. HAP lettuce varies between 5 and 7 EGP/piece. From a price point of view this is acceptable for 4 and 5 star hotels and high-end restaurants.
There is another advantage to target hotels and restaurants in particular. Customers in these places very often are tourists from abroad and hence the products currently produced by the HAP farms are very common to these customers, contrary to the Egyptian people. On the other hand, if the products are not cooked, there could be a lack of trust with respect to food safety.

[11] *http://www.gourmetegypt.com/catalogsearch/result/?q=hydro, viewed at 3-12-2015*
[12] *This does not imply the value for money is wrong, but only decreases the population share that can afford it*

The water used for cleaning vegetables could make people sick, implying a reticent attitude towards fresh vegetables.

In this period, end of 2015, the tourist sector is suffering from safety issues in Egypt. Hotels are empty and only agree on long term payment agreements of 90 days, which is unacceptable for small companies like Egyptian Hydrofarms and Bustan Aquaponics. Hence currently customers of the farms are mainly restaurants. A 'Dutch' example is the restaurant 'A Table' opened on November 13, 2015 in Sheikh Zayed City in West Cairo. They source iceberg lettuce from Egyptian Hydrofarms.

From a logistic point of view the restaurants and hotels should have a minimum size. Egyptian Hydrofarms sells 5-7 kg on average to a restaurant and 15-20 kg to the hotels, and if one day of delivery has 500-1000 pieces of vegetables lots of stops are needed in a city full of traffic jam.

Figure 8: Egyptian Hydrofarms: delivery size for hotels and restaurants, credits Han Soethoudt

Summarizing on the main issues for HAP sales we have:

a) Volume: given the current situation of production hotels and restaurants of medium scale are a good target market for the two farms, although logistic costs are relatively high[13].
b) Price: in the out of home outlets a consumer does not pay for a vegetable, but for a meal. Hence the price is less of a threshold compared to retail, especially since no extra margin is incorporated. Moreover 4 and 5 star hotels and high-end restaurants can easily afford it.
c) Products: in the high-end out of home customers very often are foreigners, that are used to eating leafy vegetables more than the Egyptian consumer.

4.3 Consumer

Emerging economies, although Egypt is just starting, show various characteristics that are relevant in the context of food. One of the most important ones is the shift from production driven to market/consumer driven food supply chains. The consumer is getting 'in charge'.

[13] Also if the 2 farms do not distribute themselves to the customer, but to a logistic hub, the logistic costs are relatively high but for someone else and that affects the price

Convenience, assortment, price and quality found in markets are more and more determined by the composition of the Egyptian population. Retailers are gaining market share because they respond to these developments by one stop shopping and cash desk driven assortment. If the average income is increasing (Figure 9) people have more choice in food. An example in many countries is the shift from vegetables to meat consumption. The change in the food basket of the Egyptian consumer is relevant for future development in agricultural production. A study from 2013 provides the food basket from 2009/2010 (see Appendix C). This study also shows that the biggest increase over the last years in food expenditure to be in animal products like meat, milk and eggs (Dawoud 2013) supporting the claim that income is increasing. Although these data are not consumption but expenditure data, they are strongly related.

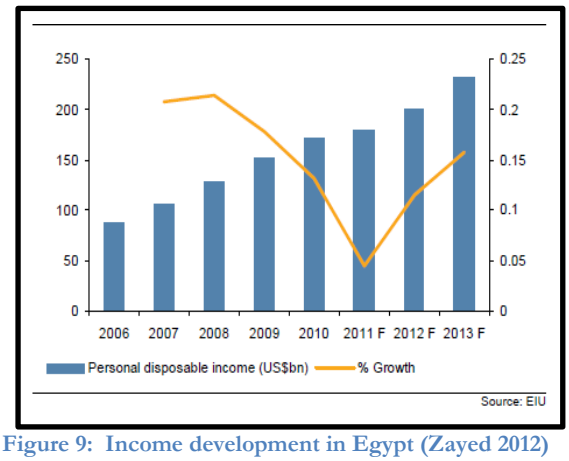


Figure 9: Income development in Egypt (Zayed 2012)

Currently HAP is very limited in production size and assortment. Some leafy vegetables and herbs are available as discussed in 2.2. These vegetables are not main stream in Egypt as can be derived from consumption data. Unfortunately the most recent data found on vegetable consumption are from 2000 (Dawoud 2005) (Table 4).

Vegetable	Average annual consumption from 1987-2000 (kton)
Tomatoes	4378
Onions	902
Eggplant	413
Squash	398
Broad bean	338
Cucumber	326

Table 4: Average vegetable consumption in Egypt 1987-2000

The HAP is not focused on the top vegetables with respect to consumption. The reason for that might on the one hand be technology driven, but on the other hand be strategic because of small scale startups. The demand for tomatoes was and is still huge (see next section) and the available production acreage and technology is not there yet. Nevertheless experts from Rijk Zwaan support the idea to go for HAP of tomatoes and other main stream vegetables.

4.3.1 Focus group

Figure 10: Focus group discussion in Cairo, credits Han Soethoudt

To gain insight in the potential of HAP a focus group was organized in Cairo among high-end consumers, which is the target group because of the high price and quality of these products. The group consisted of 8 people (directly or indirectly) responsible for household food purchase. Statistics on these 8 consumers are:

	Topic	Result
1	Frequency per week of eating lettuce (average)	
	- at home	3.1
	- out of home/at work	1.6
2	Frequency per week of purchasing (average)	
	- vegetables	2.0
	- lettuce	1.4
3	Purchasing in	supermarket (Metro, Alfa, Seoudi, other)
4	Most important issue for selection of outlet	1. product quality 2. nearby 3. service
5	Important when buying lettuce	1. strength of leaves / color 2. appearance / fresh

Table 5: Statistics of 8 participants in focus group

Besides the personal background[14] these statistics confirm the composition of the focus group as being high-end consumers, since on the one hand they purchase vegetables in supermarkets and on the other hand product quality and convenience are the most important purchasing issues, whereas price is not.

A focus group is not a methodology to achieve statistically reliable results, but to gain insight in the consumer behavior in a qualitative way. Therefore results are ways of thinking that need to be validated on their representativeness. Nevertheless relevant knowledge is acquired to give direction to decision making, eventually supported by more statistical evidence in research carried out later. Remarks heard repeatedly are listed as such:

- Lettuce is not a very common vegetable in Egyptian households. Many times tomato and cucumber are used for breakfast and dinner.

[14] *Personal information is shared during the introduction of the focus group like profession*

- Tomatoes should be hard, so you can cut them for a salad. Soft tomatoes should be cheaper, since you can only use them in soup or sauce.
- They do not always trust restaurants with respect to hygiene and might (like many tourists) not eat fresh vegetables in a meal served in a restaurant.
- Supermarket vegetables are cleaned and packed, which is not the case on the streets.
- Supermarket vegetables last longer than street vegetables, the latter having only 1 or 2 days.
- Price is not a priority decision factor when purchasing food but the 12 EGP/piece for a romaine lettuce (Egyptian Hydrofarms is Alfa supermarket) was too expensive for all but two.
- The HAP lettuce in the product sample had a great appearance but the taste of the romaine lettuce was not appreciated that much.

In addition to the discussion products are evaluated during the focus group discussion. The set-up of this product evaluation was as follows:

For Romaine lettuce and tomatoes all participants were asked to:

1. score the products on a score from 1 to 10 without knowing price or outlet
2. provide the purchasing order of the four products while knowing the price (1 = first choice for purchase)
3. Tell whether they would buy the product or not when they know the price

Romaine lettuce:
Four Romaine lettuces were collected from various locations. Note that more supermarkets were visited, but in several cases like Metro, Spinneys, Carrefour and Panda the product was not in the assortment. One of them is taken directly from Egyptian Hydrofarms (sold in Sunny market). Pictures of the products are shown in Appendix D.

ROMAINE LETTUCE					
Outlet	Price	average score (1-10) without price info	order in purchase with price info	Buy	
				yes	no
Hyperone1	1,5 EGP/piece	5.8	2	3	4
Alfa market	4,75 EGP/kg	2	4	0	7
Open market	1,5 EGP/piece	8.1	1	6	1
Sunny market	12 EGP/piece	8.6	3	2	5

Table 6: Product scoring for lettuce during focus group

Tomato:
Eight locations were chosen to collect tomatoes. HAP is not available yet for tomatoes, so comparison for this product is not possible. Pictures are shown in Appendix D.

TOMATO					
Outlet	Price	average score (1-10) without price info	order in purchase with price info	Buy	
				yes	no
Metro	7,5 EGP/kg	3.5	7	0	5
Metro	12,5 EGP/kg	5.5	4	0	5
Alfa market	7,95 EGP/kg	4.4	5	1	4
Alfa market (organic)	16,9 EGP/kg	6.0	6	1	4
Spinneys	3,5 EGP/kg	5.9	3	2	2
Open market	5 EGP/kg	8.3	1	4	1
Hotel Sofitel	no price	7.8			
Panda	3,95 EGP/piece	8.4	2	5	0

Table 7: Product scoring for tomatoes during focus group

The results from Table 6 show that the hydroponic romaine lettuce scores high on appearance, however is only third when price is known. For five out of seven people the price is too high. This might indicate that the target group of consumers is very small.

Note that not all data could be used for the analysis otherwise 'Buy' would add up to eight.
For tomatoes the open market, Hotel Sofitel and Panda supermarket stand out from the rest. The strange thing is that prices are the lowest. It is important to stress that these results are far from representative. The sample size is too low and within supermarkets some products are good and others are bad. What it does indicate is the focus of this consumer group on product quality.

Figure 11: shelf with vegetables in Panda supermarket (several vegetables look good, whereas broccoli does not), credits Han Soethoudt

Striking is the fact that the open market products do well in both samples. First choice if price was given. The participants did not know where the products were purchased and since the keepability and hygiene is perceived less from the open market they probably would score otherwise if they knew.

Summarizing the HAP in relation to the consumer:

a) Romaine lettuce is not a well-known vegetable in the Egyptian household consumption, whereas tomato and cucumber are. Maybe other products are better options to grow in HAP production systems.
b) The target group likes to shop nearby (convenience, time).
c) The target group prefers purchasing vegetables from supermarkets rather than open markets because of hygiene and keepability.
d) Price is not the main purchase decision factor, however if it is too high it narrows down the potential.
e) Product quality is the main driver for purchasing vegetables within the group of high-end consumers.
f) Taste of HAP products could be an issue that needs further investigation.
g) HAP Romaine lettuce has a very good appearance.
h) Strength of leaves and color and the main sensory aspects for Romaine lettuce.
i) Tomatoes are preferred to be hard.
j) The target group is not confident with respect to hygiene in out of home eating, which implies a justification for higher prices in case of HAP.

5 Indicative Business case

Finding opportunities for setting up a pilot with more resource efficient agriculture production systems (like hydroponic and aquaponic production) requires analysing the entire supply chain from production to consumer and setting up a business case that makes participation in the pilot interesting for all stakeholders. We have looked into tomato, the most commonly consumed vegetable crop in Egypt, as well as into leafy vegetables, which are currently the main products on hydroponic production basis in Egypt. Based on the input received from the consumer research and the expert interviews at the supply side, an indicative business case can be drafted.[15]

5.1 Tomato

The players in the chain have much greater expectations from tomatoes than lettuces. Tomatoes are considered the best opportunity to increase productivity while decreasing water usage. Hence the following case was drafted for tomato.

On the consumer side the following assumptions were made:

- The population share willing to pay a premium price for high quality, healthy and safe tomatoes are equivalent to the population share buying their fruit and vegetables at hypermarkets or premium supermarkets. This is the addressable population share for the product.
- Combined hyper- and premium supermarkets have a market share of c. 10%. For consistency reasons we only took the hypermarket channel into account (5.7% in 2014) where the recent expert interviews were conducted.
- The long-term share of hydroponics tomatoes that can be reached in hypermarkets is estimated at 20%.
- Based on the focus group data we established the assumption that the addressable population share is willing to pay 5-10 EGP per kg.

Based on the assumptions regarding the retail market and the consumers we come to a potential long term annual consumption volume for hydroponics tomatoes of c. 94 million kg.

Indicator	Value	Unit	Source
Annual Consumption per capita	91.3	kg	FAO stat
Addressable Consumer Base (hypermarket share 2014)	5.7%		Orestes Vasquez 2015
Population Egypt 2015	90,000,000		CIA fact book
Population Growth Rate (CAGR2025)	3%		index mundi
Addressable Population (hypermarket share)	5,130,000		Orestes Vasquez 2015

[15] *For confidentiality reasons the details of the calculation cannot be published*

Total Annual Tomato Consumption Egypt	8,217,000,000	kg	calculated
Addressable Consumption Base	468,369,000	kg	calculated
Addressable hydroponics share (long term % of retail hypermarkets)	20.0%		expert judgement
Addressable Hydroponic Consumption	93,673,800	kg	calculated

Table 8: market potential analysis tomatoes

The production analysis is based on the following assumptions:

- As calculated here above the targeted production volume will in the long term be c. 94 million kg/year.
- The average yield of hydroponics tomatoes is 25 kg/m².
- Consequently, the corresponding needed production area is 375 ha.
- The technical systems will be basic systems, not fully controlled systems with related lower cost. This leads to calculated cost at farmgate of 6.80 EGP per kg of hydroponics tomatoes.

Relating this to the above established consumer willingness to pay of 5-10 EGP the financial viability of the pilot will depend to a large share on the organization of the chain between production and consumption. Branding is critical to support the added value with respect to food safety.

5.2 Leafy vegetables

As mentioned earlier four farms could be identified in Egypt that currently produce leafy vegetables in hydroponics (see Table 1). The case of leafy vegetables is entirely different from the tomato case, mainly for cultural and dietary habits of the Egyptians, who rarely consume lettuces in salads. The main types of lettuces remain Iceberg and Cos, which are applied in fast food and warm dishes. The latter lettuce types are not included in this study.

For leafy vegetables the following assumptions were made on the consumer side:

- The population share willing to pay a premium price for high quality, healthy and safe tomatoes are equivalent to the population share buying their fruit and vegetables at hypermarkets or premium supermarkets. This is the addressable population share for the product.
- Combined hyper- and premium supermarkets have a market share of c. 10%. For consistency reasons we only took the hypermarket channel into account (5.7% in 2014) where the recent expert interviews were conducted.
- The long-term share of hydroponics lettuce that can be reached in hypermarkets is estimated 20%.
- Earlier market research showed prices of 30 to 80 EGP/kg for leafy vegetables (Nina Waldhauer 2014). It has to be taken into account that the lower end of this price range applies to lettuces and the higher end to baby leaf salad and herbs.

Based on the assumptions regarding the retail market and the consumers we come to a potential long term annual consumption volume for hydroponics leafy vegetables of c. 3 million kg/year, which is significantly lower than the potential of 94m kg/year for tomatoes.

Indicator	Value	Unit	Source
Addressable Consumer Base (hypermarket share 2014)	5.7%		Orestes Vasquez 2015
Population Egypt 2015	90,000,000		CIA fact book
Population Growth Rate (CAGR2025)	3%		index mundi
Addressable Population (hypermarket share)	5,130,000		Orestes Vasquez 2015
Annual Consumption per capita in addressable population	3.0	kg	based on indicative results focus group
Addressable Consumption Base	15,390,000	kg	calculated
Addressable hydroponics share (long term % of retail hypermarkets)	20.0%		expert judgement
Addressable Hydroponic Consumption	3,078,000	kg	calculated

Table 9: market potential analysis leafy vegetables

The production analysis is based on the following assumptions:

- As calculated here above the targeted production volume will in the long term be c. 3 million kg/year.
- The average yield of hydroponic leafy vegetables is 30 kg/m².
- Consequently, the corresponding production area is 10 ha.
- The technical systems will be basic systems, not fully controlled systems with related lower cost. This leads to calculated cost at farm gate of 5.66 EGP per kg of hydroponics leafy vegetables.

Relating this to the earlier mentioned current prices of 30 – 80 EGP, this business case seems financially more interesting. However, this has to be related to what was described here above: eating leafy greens is not a well-established habit in Egypt and much of the production goes to fast food. Thus, setting up a pilot would require an immediate high volume of a steady supply of high quality volume, which makes the set-up of such a pilot more complex and more vulnerable for failure.

It should be mentioned that this calculation is exclusively targeting the local demand of the retail and food service channels, so no exports are considered. Anecdotal references suggest that export to the Gulf area is a potential viable business case.

6 Conclusions

Based on this study the following conclusions are drawn:

a) Based on literature and field research, water scarcity turns out to be an important driver for hydroponic and aquaponic production.
b) Consumers are not sensitive yet to the added value of hydro- or aquaponics productions, being attractive in water use; instead they buy products that have as main characteristic that they are of good quality. The target clients for producers are high-end retailers that are quality and service driven rather than price oriented. Moreover in the startup the size of the retailer should be limited to be able to match the supply with the demand.
c) Until now only leafy vegetables and herbs are produced using hydro- and aquaponics systems. Since Egyptian consumers are not used to eat these leafy vegetables as a main crop a shift to other vegetables, like tomato, looks more promising.
d) The best opportunity for a business case is hydroponic production of tomatoes for a small high-end retailer like Sunny or Alpha supermarket.
e) The interviews revealed significant interest and triggered follow-up questions from interviewees to be involved in case a pilot project would be initiated. Some even wanted to take the initiative to directly invest in a hydroponic production operation.

The Economic department of the Netherlands Embassy in Cairo took the lead to develop a symposium dedicated to the subject of hydroponic production in Egypt. All players on the Egyptian and the Dutch side of this new value chain are invited to attend. This symposium is scheduled to take place in April 2016 and the ambition is to develop a pilot as a result of this research and that symposium.

References

Dawoud, S. (2005). "An analysis of food consumption patterns in Egypt; dissertation." 209.

Dawoud, S. (2013). "Econometric analysis of the changes in food consumption expenditure patterns in Egypt." 11.

Nina Waldhauer, H. S. (2014). "Metropolitan food supply in Egypt: Market analysis hydroponics production for selected urban areas." 24.

Orestes Vasquez, I. M. (2015). "Egypt - Retail Foods - 2014 Retail Food Sector." 29.
UNFPA (2008). "State of the world population 2007 - unleashing the potential of urban growth." 108.

FAO and DWFI. 2015. Yield gap analysis of field crops – Methods and case studies , by Sadras, V.O., Cassman, K.G.G., Grassini, P., Hall, A.J., Bastiaanssen, W.G.M., Laborte, A.G., Milne, A.E., Sileshi , G., Steduto, P. FAO Water Reports No. 41, Rome, Italy.

FAO, WFP and IFAD. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO.

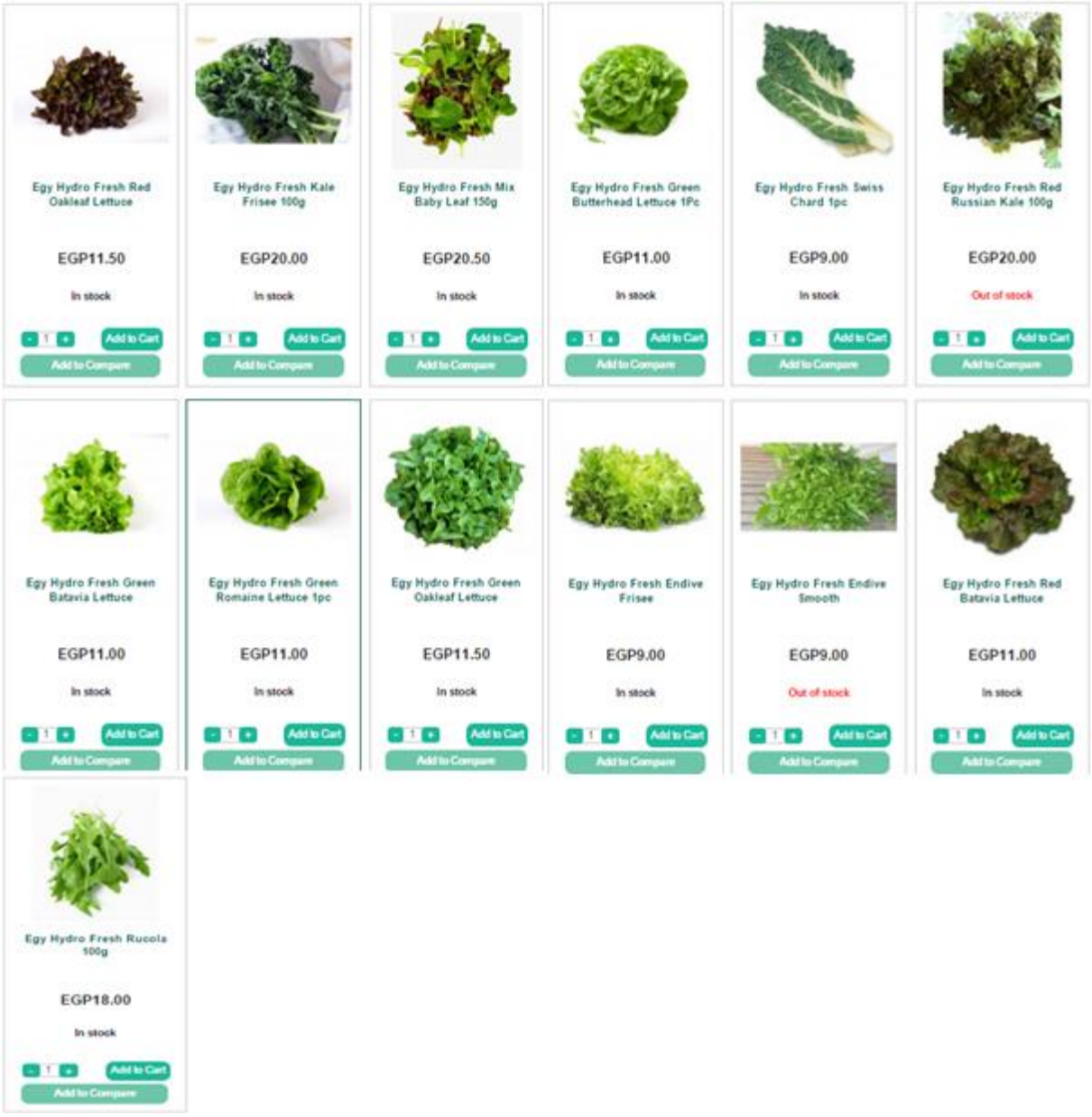
Appendix A

% retail value rsp excl. sales tax	Company	2011	2012	2013	2014
Metro	Mansour Mfg & Distribution (MMD)	2.7	2.7	2.5	3.0
Ragab Sons	Ragab Sons for Trade & Distribution	0.9	1.8	2.4	2.4
Carrefour	Majid Al Futtain Hypermarkets LLC	1.3	1.5	1.5	1.7
Kheer Zaman	Mansour Mfg & Distribution (MMD)	0.7	0.8	0.9	0.8
Spinneys	Spinneys Egypt Ltd	0.6	0.7	0.7	0.7
Zahran	Zahran Group	0.3	0.5	0.6	0.6
Carrefour Market	Majid Al Futtain Hypermarkets LLC	0.2	0.4	0.5	0.6
Al Mahmal	Al Mahmal Co	0.2	0.3	0.4	0.4
Hyper1	Al Hawary Co	0.5	0.5	0.4	0.4
Fathalla	Gomla Marke Co	0.3	0.3	0.4	0.4
Seoudi	Seoudi Co	0.4	0.4	0.4	0.4
Awlad Ghanem	Al Marwa For Trading & Distribution Co	0.2	0.2	0.3	0.3
Alfa Market	Alfa Market SAE	0.2	0.2	0.2	0.2
Mobil Market	Exxon Mobil Corp	0.1	0.1	0.1	0.1
La Poire	International Co for Sweets Production	0.1	0.1	0.1	0.1
Esso Snack & Shop	Exxon Mobil Corp	0.1	0.1	0.1	0.1
Oscar	Oscar Supermarket	0.1	0.1	0.1	0.1
Abou Zekry	Abou Zewkry SAE	0.1	0.1	0.1	0.1
Royal House	Royal House Supermarket	0.1	0.1	0.1	0.1
Abba	Abbanoub Inter Trade Co	0.1	0.1	0.1	0.1
Others	Others	90.8	89.2	88.0	87.3
TOTAL Grocery Retailers		100,0	100,0	100,0	100,0

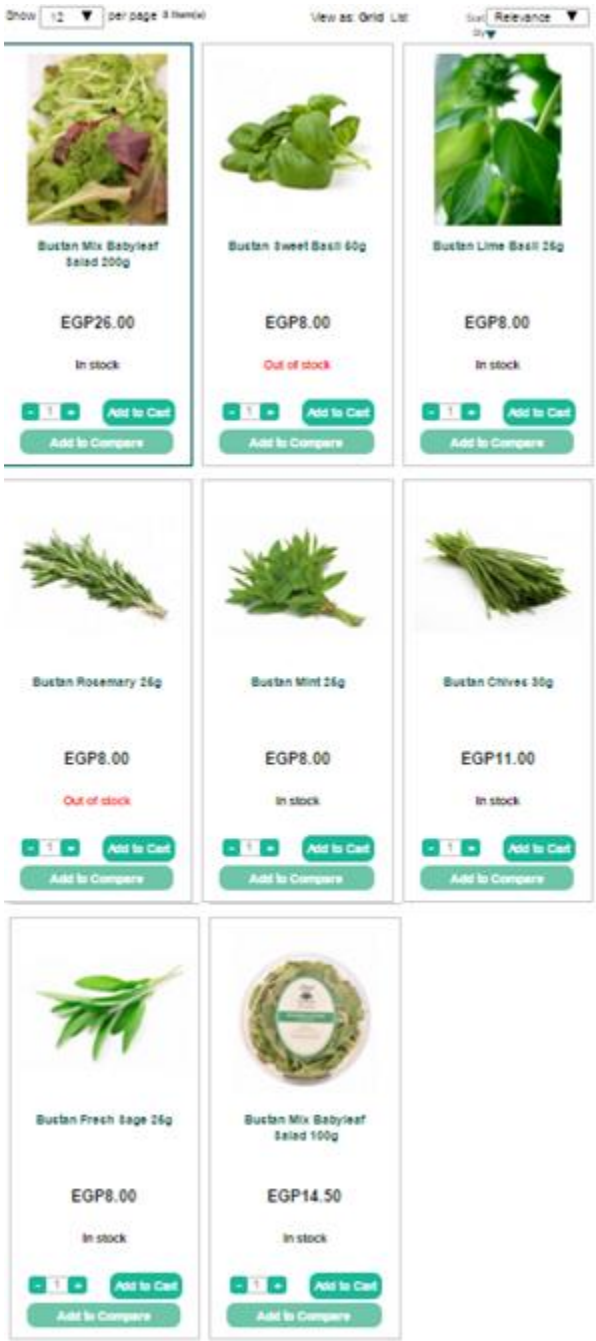
Table 10: Egyptian retail landscape

Appendix B

A. Products from Egyptian Hydrofarms



B. Products from Bustan Aquaponics



Appendix C

Food category	Average annual per capita expenditure (LE) in 2009/2010 in urban areas	%
Meat	485	27%
Milk-eggs	269	15%
Cereals	241	13%
Vegetables	234	13%
Oil-fats	151	8%
Fish	131	7%
Fruits	129	7%
Sugar	81	4%
Beverages	64	4%
Other food products	36	2%
TOTAL	**1821**	**100%**

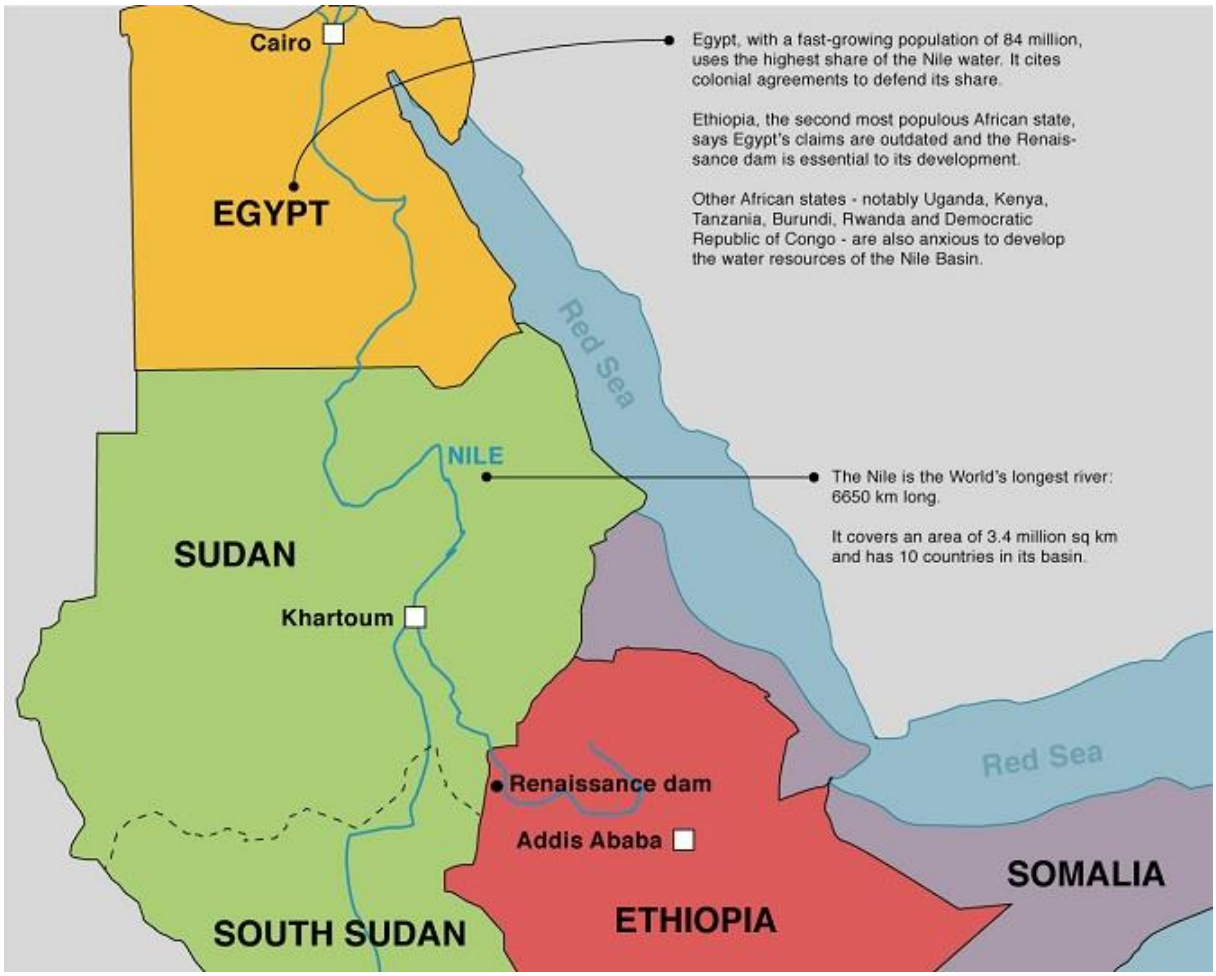
Table 11: food expenditure in urban areas in Egypt in 2009/2010 (Dawoud 2013)

Appendix D

1 HyperOne1	2 Alfa market
3 Open market	4 Sunny market (hydroponics)

Appendix E

Water Resources & Geo-Political Disputes



Source: http://america.pink/water-politics-the-nile-basin_4742573.html (viewed 31-3-2016)