

THE DIFFERENT ASPECTS OF THE SUSTAINABLE FOOD PRODUCTION FOCUSING ON GREENHOUSE TECHNOLOGIES

György Gonda, Noor Mubarak Y. M. Al-Ali, Maria Fekete-Farkas

Szent István University, Hungary, H-2103 Gödöllő, Páter K. u. 1. Hungary

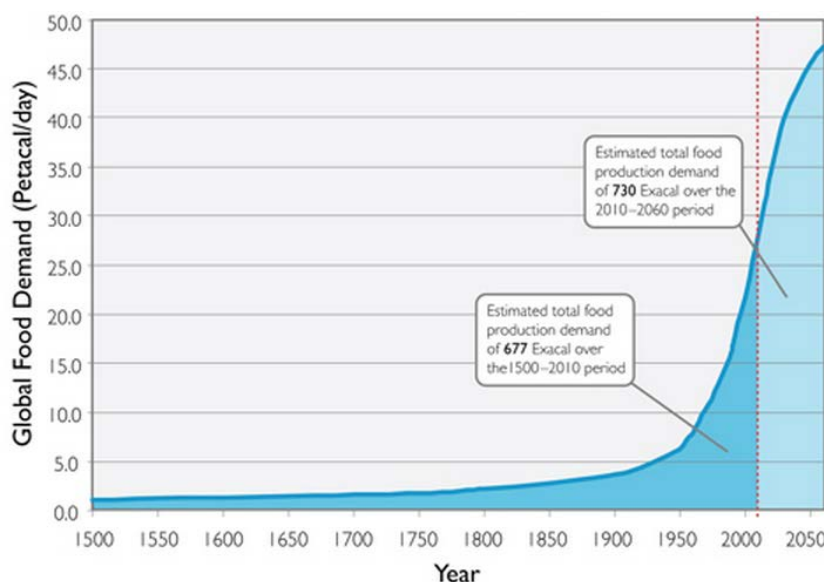
Abstract

The goal of sustainable production is to promote economic viability, use of resources and energy and land efficiently and increase or maintain stable the quality of life. The food production, specifically the greenhouse fruit and vegetable production is one the area which can contribute to this goal in different ways. In this paper we introduce the motivation factors and drivers behind the developments towards greenhouse production in different climate conditions. We present the greenhouse production market restructuring with new players. What kind of difficulties arise in the open field vegetable production and what benefits can be realized by the customers and producers from the covered greenhouse technology in the continental and desert climate? As an example, we analyze Qatar's energetics, climate conditions and food resources, Qatar's food supply process and its barriers. We will show how the sustainability and food safety appear in Qatar's National Strategy Plan.

Key words: sustainability, food safety, greenhouse production, Qatar

1. INTRODUCTION

The world's agriculture and food industry will have to face huge challenges in the following decades. Today, 3 billion people rely on food which is produced elsewhere and transported to the cities, and it will grow to 7 billion by 2050, according to the projection of FAO (FAOSTAT, 2013). To meet the increasing demand of the people, the agricultural production must be increased by 60% from its 2005–2007 levels (FAO, 2013). Apart from the increasing population, its consumption pattern also changes due to the higher income and health concerns (Figure 1). Higher consumption per capita increases especially in the emerging regions like Asia, Northern Africa, Latin America.



* Exacal = 10^{18} calories

Figure 1. The challenge to produce enough food will be greater over the next 50 years than in all human history

Source: Cribb, 2011

The present agricultural technology with the limited natural resources (land, water, fossils) together with the increasing demand for bioenergy can lead to the food shortage.

The greatest challenge is in increasing the agricultural production to such high level is to carry it out in a sustainable way in order to secure food safety for the longer term. Therefore countries need to shift to more sustainable food systems to enable sustainable development aiming to lower the long term vulnerability of economic, social and ecological systems (Mubarak et al, 2014).

The vulnerability of the poor countries high, because they have less power and fewer means to act, and also because they are mostly located in marginal production areas, where they are more exposed to the impact of climate changes.(FAO, 2013)

However, not only the poor and undeveloped countries can be suffer from the lack of food safety, even those who have well developed economy have to face high risk, if they don't possess the appropriate resources for food production, like Qatar for example.

Urbanization with the megacities brings in new risks to food safety as well, since food safety rely on the stable logistics of the food products. The more distance they have to deliver food to the consumers in the city the greater problems they face when problems arise in the logistical change, just like in Australia in Brisbane during 2010 December, when all the supermarkets were emptied in 2 days, because the transportation was cut off by the flood (Australian Government, 2012).

The changing of food prices is the other factor which makes the low income population more vulnerable.

The food prices have started to increase in 2008 as another result of the global crises. According to most of the agro-economic models, a tendentially increasing price level is projected for the next decades.

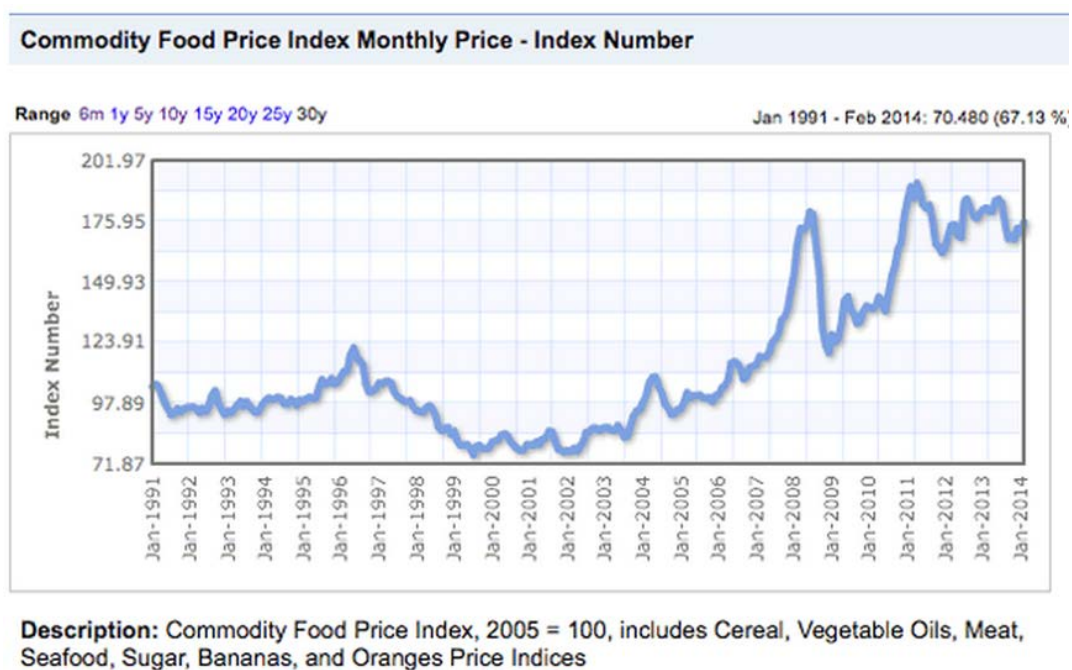


Figure 2. Past trend of world commodity food prices

Source: FAO, 2013

In the less developed countries, the consumers' price elasticity demand is high, which will result a higher fruit and vegetable consumption level compared to the animal products (NL EVD International, 2011).

In the high income countries, the food consumption pattern is changing because of health concern, which brings also a higher need for vegetables. The higher demand for fruits and vegetables leads to higher intensity in

research and development activities in the agricultural production for increased productivity and for the producers gaining market advantages.

The required higher level of agricultural production will generate increasing environmental risks. The potential of the agricultural production is limited, because the required major resources as water, land, nutrients, energy are not infinite and in addition, the geographical distribution of the resources is uneven.

In the below graph, we can see the richest and the poorest counties of the World, in terms of quantity of arable lands per capita (Figure 3):

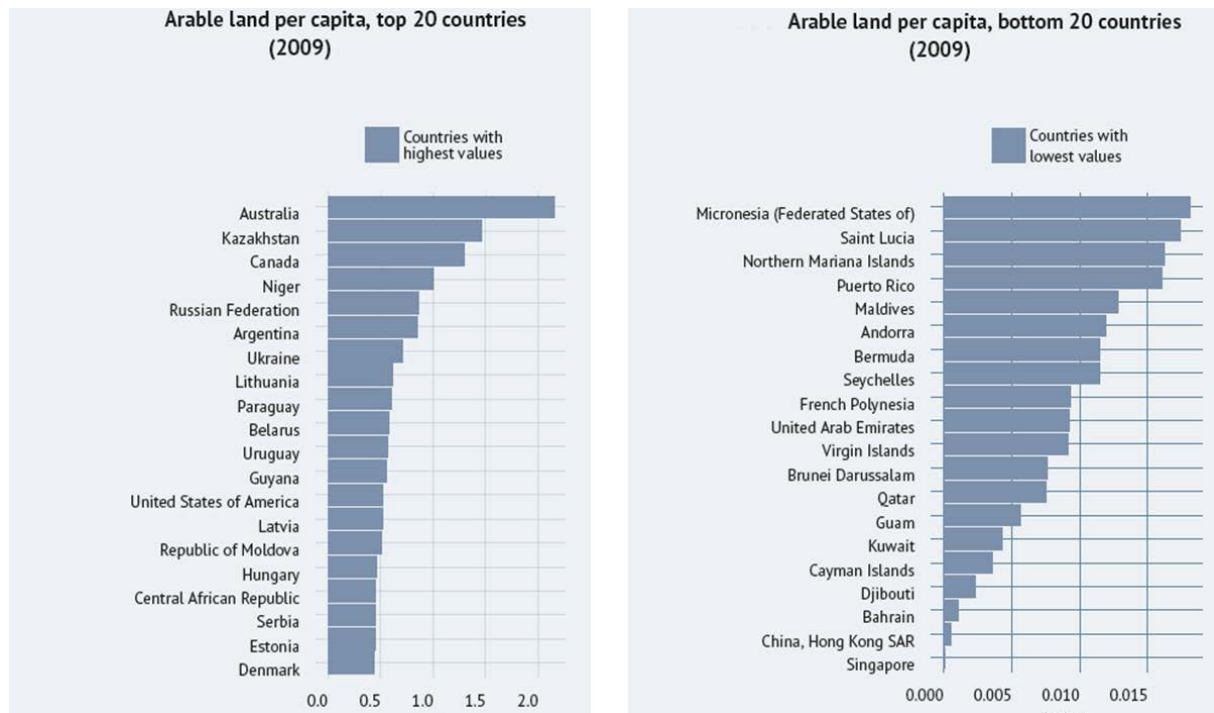


Figure 3. Demonstration of uneven geographical distribution of arable land

Source: FAO, 2013

Today, the natural resources are used very intensively by the agriculture. 70 percent of the abstracted freshwater is used for irrigation and only 30 percent used by industrial and household purposes. 30 percent of the total land area of the Earth is used for agricultural production. These large-scale utilization of the natural resources means larger environmental threat. These major resources needed to secure our food supply: water, land, nutrients, energy, technology, skills, finance and stable climates (Australian Government, 2011)

From the required essentials of the of the production, the following resources are going to reach their maximum peak volume of their utilization in the near future.

- water
- land, concerning degradation, urbanization, population and infrastructure grow
- fossil energy
- artificial fertilizers' row materials (like phosphor and potash) (Rijsberman, 2012)

The greenhouse technology open a new perspective and possibility to overcome the scarcity of the essential resources of the agricultural growing. In different climatic and terrain conditions, the greenhouse technologies can supply appropriate conditions for the vegetable and fruit growing, with enabling stable climate, soilless production, water saving irrigation, pest control, thus realizing stable and high quality yield .

Main drivers behind greenhouse production:

- benefits of the local production: short supply chain lowering transport costs, longer lifetime of product from harvest to consuming, because it can be harvested just in time when the demand arises
- less costs due to lower waste
- stable quality needed by the consumers and distributors
- higher demand for environmental friendly products and organic growing
- emotionally linked consumers to local produced vegetables
- food safety
- possibility for soilless production.

2. MATERIALS AND METHODS

The results presented in this paper are based on related international literature, company reports, personal interviews with experts, and the authors' own professional experience.

3. IMPORTANCE OF GREENHOUSE PRODUCTION IN EUROPE AND OTHER PARTS OF THE WORLD

Although Europe is well supplied with the necessary resources for agricultural production, even the European Union has to face serious challenges in the future, as:

- climate change
- increasing competition for water and arable land resources
- rising costs of inputs (fertilizers, fossil energy, etc.)
- changing of consumer diets because of health concerns and ageing population
- competition for export markets

Greenhouse technology production traditionally present in Europe and has already reached very high technology level. The European production is characterised by a climate conditions associated to four climate regions, which allows for diversity in technologies and practices used for greenhouse vegetable production. Some countries of Europe are the leaders in the world greenhouse technology developments and obtain a large market share, for example the Netherlands or Italy. Due to the increasing demand for higher and stable quality for fruits and vegetables during the whole year, EU is the main export market destination of the world. That is one of the main reasons, why 20% of the total greenhouse surface area belongs to Europe according to FAO in 2009 (FAO, 2013).

Apparently, some of the non-European producers like Morocco, Egypt or Israel are able to deliver their high and guaranteed quality products to the Western markets and compete the European price level thanks to their continuous production development and lower labour costs. (Carb growth, 2011).

Apart from the existing and experienced greenhouse horticultural players in the developed and less developed part of the world, due to the increasing demands and future risks, new – traditionally non-agricultural countries with marginal lands will also enter the greenhouse production thus taking non arable lands into food production.

We can find countries among these, with high per capita GDP and high dependency of food import.

In the literature, the sustainability issues are well analysed and presented about those countries on one hand, which are energy dependent with intensive agricultural production – focusing on energetics and food supply, or on the other hand about countries suffering from hunger and poverty – focusing on food production. The sustainability issues have not been widely discussed related to those economies, where there is no fossil energy dependency from the consumer side, however they take serious steps for preserving their well-being for the future generations because of their vulnerability from the lack of food safety and their economic dependence from the fossil exports.

In the following, we introduce and show through Qatar's example, that an oil exporter country with marginal arable lands, what kind of characteristics and parameters has and what plans and actions has been made towards food safety and sustainability.

We find Qatar a good example also for showing, that sustainability issues are always come to front, when the vulnerability appears on the horizon.

4. QATAR'S NATURAL RESOURCES AND ECONOMY

In Qatar the land which can be used for agriculture measured at 5.61% of the total land according to the World Bank. Qatar is a rocky desert area with some oases formed by 850 separate depressions. In Qatar arable land defines land under temporary crops, temporary meadows, land under market or kitchen and land temporary fallow. The lands are highly saline. The total cultivated area is 6 322 ha, including 67 ha of greenhouses. The total area of arable land is 2 651 ha, which includes 1 190 ha of vegetable crops and 1 461 ha of field crops. The area under permanent crops amounts to 3 412 ha and comprises 1478 ha of perennials and forage crops and 1 934 ha of fruit trees (FAO, 2002).

Qatar's performance has been constantly growing in the last decade and planning to sustain the high performance is an ultimate goal for the State. But every country or state needs to consider that besides economic growth the environment must be preserved and protected.

In general, the Gulf countries are wasteful in consumption; hence changes will be done to put in place preventive measures to mitigate the negative environmental effects of pollution resulting from the development activities. Preventive moves needs to be done in order to sustain the natural life. The Qatar National Vision 2030 sets initiations to perform actions towards sustainability even in environmental developments. The State of Qatar considers environmental issues as key drivers in achieving the national goals. Qatar is in a unique position, given the financial resources and forward thinking leadership, to move ahead and be amongst the leading countries ready to take advantage of the next economic revolution: the green revolution.

The most important topics affected environmental developments are: water sector, (water resource development, water security, water loss control and water management, and water quality standards), marine environment, climate change, and waste management. Marine water with advanced technology can be transformed potable water. The high intensity of solar power is available to transform into electricity, and the very frequent powerful winds are also possible to create it, therefore the variety of actions are wide in order to achieve the so called green revolution. Creating Qatar water and food secure through sustainable technologies is key point in sustainable development. In this field establishing leading edge food production systems as exemplar for agriculture in dry lands. One of the main objectives of Qatar is to become the food hub of the Gulf region due to its geological and economic status. Besides these for coming trends the green technologies are emphasized through all the national strategy plans.

The food production in domestic soil is very hard and challengeable job. The number of the decline of active farms since 2008, more precisely -30%. The food dependency is very high, 90% of all food consumed in Qatar is imported. (QNFSP, 2013)

Qatar belongs to one of the most food- import-dependent counties in the world, and it is even expected rising further in the future. In Qatar the opportunities of food choices were always being limited due to the dry lands. The main consumption were rice and sea foods due to the Persian and Indian migration. The high food-import-dependency can be addressed to both demand and supply-side factors. In the demand side there has been a lot change recently in the habit of food consumptions due to the high number of expatriates who insist on their own food. The Westernized meals have also become popular on the supply side even among local people. Fast-food restaurants have found way into the local market, therefore the production of own food is not a necessity anymore from the consumers' point of view.

5. FOOD SECURITY ISSUES IN QATAR'S NATIONAL STRATEGY

The mission of the Qatar National Food Security Plan (QNFSP) is to manage the food security by setting goals and giving directions for the government and private sectors. The main tasks what the QNFSP should accomplish:

- Develop policies, plans and capacities that enable the nation's food system operationally

- Monitor, assess and improve the performance of key parts of the nation's food system
- Provide outstanding/leading/ expertise that contributes to a knowledge economy in Qatar and provides services that contribute to global progress on food and water security
- Promote and support opportunities for the private sector

Concerning the expertise in Qatar and the global practice inside the framework of Qatar's National Vision 2030, the QNFSP (Qatar National Food Security Plan) was established to step towards sustainable food safety. The plan lays down a 10 year roadmap with actions for improving the national food system. The plan outlines 3 key principles:

- Improving the flexibility of the State of Qatar
- supporting environmental friendly and economically and socially sustainable developments
- strengthening and motivating the private sector's involvement into the economic growth

These key initiatives include:

- better technologies and practises have to be adapted for increasing efficiency and sustainability, and by transitioning to the high efficiency production farms will be able to produce 40% of the total food volume of the nation on the same amount of land with one-third less water, then it is required today
- strategic water reserves must be established
- boosting strategic food reserves
- diversifying trading and investment activities, improving and widening domestic market
- international cooperation and collaboration for food safety

At present time, the government of Qatar and the stakeholders are working to initiate the detailing and implementation of the QNFSP to form the plan into actions and realization.

5. SUSTAINABLE DEVELOPMENT REALIZATION

The strong need for utilization of non-arable lands has helped to be bring in innovation and develop technologies which can make it possible greenhouse production even in the desert.

To be able to grow, stable, precisely controlled optimal condition has to be created for the plants during the year. In Europe, the greenhouse must be heated in the colder seasons or in the cold nights and Carbon-dioxide must be applied for the plants. In the desert climate, both heating and cooling are needed for creating the optimal stable temperatures. Apart from the temperature, the most significant problem is the dryness. Irrigation is a must, but finding enough water in the desert is more difficult, then in the continental climate.

It shows the great development, that there are already green spots in the desert – these new areas have not been considered as arable lands in the past, but now due to the irrigation systems, these open fields produce agricultural products in the middle of the desert.

These irrigation systems can provide enough freshwater from the pivot and also humidify the cultivation area. However, the temperature can not be effectively controlled with these technology, thus allowing only a very limited portfolio for growing.

Apart from the open field irrigation technology, already a cutting edge technology has been developed for low operation cost, cooled and heated, covered, desalting greenhouses – in the deserts. This technology produces freshwater for the irrigation from the saltwater.

A pilot project has been already realized in the desert of Qatar – for growing cucumbers using solar energy for heating and cooling and distilled salt water from the sea for irrigation.

A concentrated solar power plant (CSP) which is producing electricity from the steam generated from the salt water and solar energy – is combined with the greenhouse. The waste heat is used for heating the glasshouse and for regenerating the desiccant used for dehumidifying the air.

This combination brought alive a profitable system, which will probably mean a kick start of other similar projects.



Figure 4. Green circles in the desert of Qatar

Source: google maps, 2014

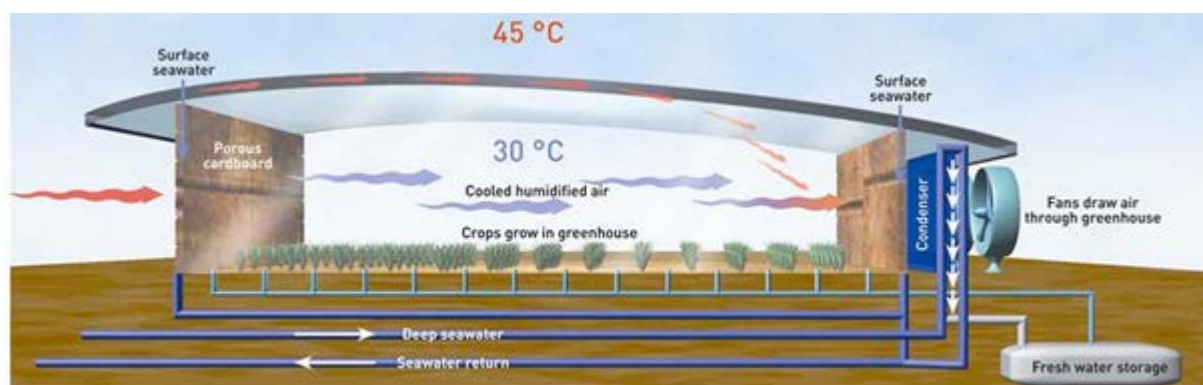


Figure 5. Illustration of a seawater greenhouse desalination facility

Source: Seawater Greenhouse Limited, 2010



Figure 6. Cucumber growing in the desert in the Sahara Desert Project

Source: Prophet,2012

6. SUSTAINABLE DEVELOPMENT REALIZATION

Although significant part of the world has aimed different goals in the sustainable development, the expected goals has not yet been realized for many reasons. In order to achieve such grandiose strategic goals, the contribution and cooperation of the different players of the national economies are needed.

Motivation of the players towards sustainability:

- private sector: environment protection, caring for the upcoming generations
- business sector: business opportunity – if there is profit, companies will support
- public sector: long term thinking, safety

How they can help sustainability:

- privat sector: select what products to buy, not only the cost should decide
- business sector: social responsibility over profit targets
- public sector: taxation, subsidy programs, education

When we talk about greenhouse production and sustainability in the the agricultural growing, we should examine, what is needed to realize a sustainable development in the horticultural sector. The realization of the sustainable change can only take place, when all these preconditions are fulfilled:

- new technologies need to be developed and adapted
- outside pressure and force to motivate the change
- need the willingness for the change from both private and public sector
- need to be able to finance the development process

Examining our example, Qatar's financial background and the willingness for sustainability both from privat and public sector, together with the available technology level from the market, we can expect that covered greenhouses will grow in the desert soon and significant local production will be realized.

7. CONCLUSION

Every country is vulnerable at food production and supply but from different perspectives and at different levels. Well developed economies have much more power to drive and invest into their future and safety, but countries with poor underdeveloped economies have to rely only on the help of other nations. As the problems arise of the overpopulation, the development and technology levels also increases at the same time. The question will be whether the technology development and the present actions of the nations can overcome the upcoming

situation, when 9 billion people will ask for food - or not. There are many promising achievements and movement already towards sustainability, but at present time they are surely not enough yet to avoid the future threat of lack of food.

REFERENCES

Australian Government, Dep. of Agriculture, Fishery and Forestry 2012, Resilience in the Australian food supply chain,

<http://www.tisn.gov.au/Documents/Resilience%20in%20the%20Australian%20food%20supply%20chain%20-%20PDF%20copy%20for%20web.PDF>

Aquastat, FAO 2002, Qatar, http://www.fao.org/nr/water/aquastat/countries_regions/QAT/index.stm (DAWR, 2002).

Carbgrowth 2011, Maximisation of greenhouse horticulture production with low quality irrigation waters, http://en.wikiioffuture.org/Maximisation_of_greenhouse_horticulture_production_with_low_quality_irrigation_waters

Csiro 2012, Sustainable Agriculture: Feeding the World - presentation by Dr Megan Clark <http://www.csiro.au/Portals/Multimedia/On-the-record/Sustainable-Agriculture-Feeding-the-World.aspx>

FAOSTAT 2013, FAO Statistical Yearbook, World food and agriculture, 2013 Food and Agriculture Organization of the United Nations, Rome, 2013

FAO: Climate change's potential impact must figure in food production efforts <http://www.fao.org/news/story/en/item/224958/icode/>

FAO 2013, Good Agricultural Practices for greenhouse vegetable crops Principles for Mediterranean climate areas, Rome <http://www.fao.org/docrep/018/i3284e/i3284e.pdf>

Cribb, J. 2011, The Coming Famine, Risks and solutions for the food challenge of the 21st century <http://www.holysee.embassy.gov.au/files/hyse/Global%20Food%20Security%20Oct11.PDF>

Mubarak, Y M Al-Ali N, Gonda, Gy, & Fekete-Farkas, M. 2014, APPEARENCE OF DIFFERENT DIMENSIONS OF SUSTAINABLE DEVELOPMENT, IN NATIONAL DEVELOPMENT STRATEGIES in „Changing, Adapting Agriculture and Countryside”. Gyöngyös, Magyarország, 2014.03.27-2014.03.28. Gyöngyös: Károly Róbert Főiskola, 2014. pp. 1157-1165.

PROPHET: Qatar's Sahara Forest Project Grows Its First Cucumbers from Saltwater - See more at: <http://www.greenprophet.com/2012/12/qatars-sahara-desert-forest-project-grows-cucumbers-from-saltwater/#sthash.flsp1Ifd>

Qatar National Food Security Programme (QNFSP), <http://www.qnfsp.gov.qa/>

Parkinson Giles 2012, Solar and seawater turn desert into a greenhouse

<http://reneweconomy.com.au/2012/solar-and-seawater-turn-desert-into-a-greenhouse-28833>

Rijsberman, F. 2012, The scramble for natural resources: How can science help? <http://purl.umn.edu/152416>

Sahara forest project: Overview of Qatar pilot plans <http://saharaforestproject.com/projects/qatar.html>

Sahara forest project: Qatar Pilot results exceed expectations <http://saharaforestproject.com/news/news-stories/qatar-pilot-results-exceed-expectations.html>

Seawater Greenhouse Limited, 2010, <http://www.seawatergreenhouse.com/projects.html>

The ministry of Economic Affairs, Agriculture and Innovation, NL EVD International (2011) : *Market Special: Greenhouse Farming in Germany* <http://duitsland.nlambassade.org/binaries/content/assets/postenweb/d/duitsland/ambassade-berlijn/zaken-doen/20110507-marktverkenning-greenhouse-farming-germany.pdf>

Babar Z. 2013, Qatar: A new era, Theedge: *Qatar's Business Magazine*, Vol. 5, No. 7/8,

http://www12.georgetown.edu/sfs/qatar/cirs/ZahraBabarFoodSecurity_TheEdge.pdf