Chapter 17
Food Security Constraints and Role of Biosaline Agriculture in Meeting Food Demand in the Gulf States

Shahid A. Shabbir

Abstract The combination of limited fresh water supplies, poor soils and hyper-arid environment (dryland system), and climate change impact in Gulf States (GS) constrains the local economic agricultural production of many crops grown for food and fodder. The difference between the Ecological Footprint of Consumption and the Biocapacity of GS, suggests a net deficit between the eco-resources generated and those consumed and wasted. Given these existing and predicted challenges, it would be hard for the GS to achieve food security unless there are considerable technological innovations in agriculture and water research to boost local production. To meet food security, GS may be seeking options of acquiring land abroad for agriculture. Leasing prime land in poor developing countries is questioned by many actors, so the sensible option is to acquire marginal (saline) lands in these developing countries, over one billion ha available globally, or acquire prime land in countries where there are resources surpluses (abundant soil and water resources) concentrated in ecological creditors' countries, which currently do not utilize their full biocapacity and the production cost is lower. In the former case, ICBA can significantly support GS in growing salt-tolerant crops (Biosaline Agriculture) in the marginal land acquired abroad and by bringing them into crop production through an integrated approach of reclamation of salt-affected lands, thus, paving the way forward for food security. Over the last 13 years ICBA has developed a world-wide reputation for its expertise in the development of salt-tolerant germplasm and applied research and development in many of the 57 IDB-member countries including the GS. The groundwater in the GS is mostly saline or brackish and biosaline agriculture is the best approach.

Keywords Biocapacity • Biosaline agriculture • Ecological footprint • Climate change • Food security

S.A. Shabbir (✉)
Salinity Management Scientist, Innovation and Research Program, International Center for Biosaline Agriculture, 14660, Dubai, United Arab Emirates
e-mail: s.shahid@biosaline.org.ae

M. Behnassi et al. (eds.), *Sustainable Food Security in the Era of Local and Global Environmental Change*, DOI 10.1007/978-94-007-6719-5_17,

17.1 Introduction

The Gulf Cooperation Council Countries (GCC countries) include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates. In this chapter they are referred as ***Gulf States 'GS'***. The GS are located in a water-scarce region, and thus most water demand is met through non-conventional water resources, that are from high-cost desalination. In addition, most of the native soils are low in fertility (low organic matter and clay contents) and productive capacity. The combination of limited fresh water supplies, poor soils and hyper-arid environment (Fig. 17.1) constrain the economic agricultural production of many crops grown for food and fodder. In addition to these existing poor resources, it is projected that the GS will be impacted greatly by the climate change through rises in temperature, decline in rainfall and an increase in evapotranspiration, e.g., the climate change impact to Abu Dhabi coastal zones, water resources and dryland ecosystem is discussed in detail (Dougherty et al. 2009).

The GS Ecological Footprint of Consumption and Biocapacity (Ewing et al. 2010) suggests a net deficit between the eco-resources generated and those consumed and wasted. Under current circumstances and with business as usual (BAU) approaches the GS will continue to be food-importing countries and seeking new options of food security and perhaps will be in the forefront of new investments in farmland abroad. There are strengths, weakness, opportunities and threats (SWOT) with such an approach. In this chapter these issues are discussed and linked with

Dryland Systems	P/PET
Hyper-arid	< 0.05
Arid	0.05-0.0.2
Semiarid	0.2-0.5
Dry sub-humid	0.5-0.65

P = Annual precipitation; PET = Potential evapotranspiration

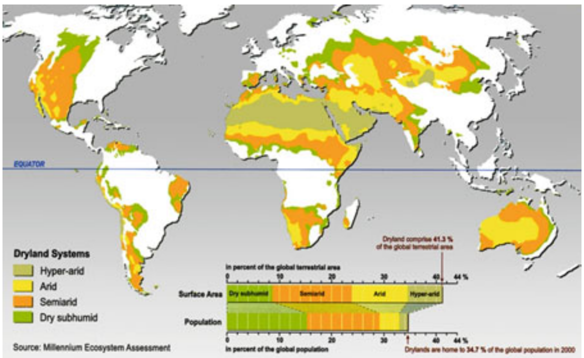

Fig. 17.1 Gulf States are in Hyper-arid Dryland Systems (Source: MEA-Millennium Ecosystem Assessment 2005)

adoption of biosaline agriculture on leased marginal lands abroad, where ICBA can significantly support the GS in bridging the gap to meet food demand.

Most of the groundwater in the GS is saline or brackish and the best option to exploit these marginal waters is through growing salt-tolerant plants (biosaline agriculture). Biosaline agriculture means growing salt-tolerant plants on salty soils using salty water. In 1999 the International Center for Biosaline Agriculture (ICBA) was established in Dubai to conduct biosaline agriculture research and to implement applied research in Islamic Development Bank (IDB) member-countries including the GS. Over the last 13 years ICBA has developed a world-wide reputation for its expertise in the development of salt-tolerant germplasm and applied research and development in many of the 57 IDB-member countries including the GS. Particularly in the GS, salt-tolerant forage production is the best approach to provide fodder and thus minimize its importation.

Significant efforts have been made in GS to narrow gaps between local food production and total food import. Water scarcity; hyper-arid climatic conditions, climate change impact, poor soil resources and poor suitability of soils for arable crops are considered the main constraints to food security.

17.2 Objectives

This chapter aims at:

– Reviewing the status of GS countries to support local agricultural production to meet food demand;
– Reviewing the ecological footprint and biocapacity of GS and relate to food security;
– Recommending the ways by which GS can explore means to meet food demand.

17.2.1 Dryland Systems

The GS (Fig. 17.1) are situated in the Dryland Systems (lack of water) area. Dryland Systems include cultivated lands, scrublands, shrublands, grasslands, savannahs, semi-deserts and true deserts like in the GS. Drylands refer to land areas where the mean annual precipitation (P) is less than two thirds of potential evapotranspiration (PET = potential evaporation from soil plus transpiration by plants). Hyper-arid areas are considered as true deserts like those in the GS. The lack of water constrains the production of crops, forage, wood, and other ecosystem services.

Four dryland subtypes are widely recognized: dry sub-humid, semiarid, arid, and hyper-arid, showing an increasing level of aridity or moisture deficit as below.

Table 17.1 Levels of water stress in the Gulf States

Levels of water stress			
Critical	**Serious**	**Significant**	**Slight**
More than 10,000 persons per million cubic metre	Between 5,000 and 10,000 persons per million cubic metre	Between 2,500 and 5,000 persons per million cubic metre	Less than 2,500 persons per million cubic metre
Kuwait and UAE	**Bahrain and Qatar**	**Saudi Arabia**	**Oman**

Source: UN-Economic and Social Commission for Western Asia-ESCWA (2007)

17.2.2 Water Stress and Water Scarcity

The GS are situated in the Dryland Systems (Hyper-arid), so they face various levels of water stresses; these are varying based on the available and renewable water resources of each country. Kuwait and UAE are under critical water stress and Oman slight water stress (Table 17.1).

One third of the world's population lives in basins that have to deal with water scarcity. Based on the map shown in Fig. 17.2 (Areas of Physical and Economic Water Scarcity 2008), the GS in general fall under physical water scarcity (water resources development is approaching or has exceeded sustainable limits. More than 75 % of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flow). This definition – relating water availability to water demand – implies that dry areas are not necessarily water scarce), except most of Kuwait which is approaching physical water scarce status.

17.2.3 World Population Since 1950 and Projection for 2050

Global population (Table 17.2) is continually growing at an alarming rate, doubling in the past half century; it is likely to plateau at some 9.19 billion by about the middle of this century, that is 272 and 362 % increase by 2010 and 2050 respectively compared to that in 1950 (Charles et al. 2010; UN 2007). The highest population growth is in the resource-poor developing African countries. In the GS, annual population growth rate of 3.5 % is reported in 2008. Continuing population and consumption growth will mean that the global demand for food will increase for at least another 40 years (Charles et al. 2010). This calls for renewed efforts to efficiently manage natural resources (soil and water) to enhance food security and safety.

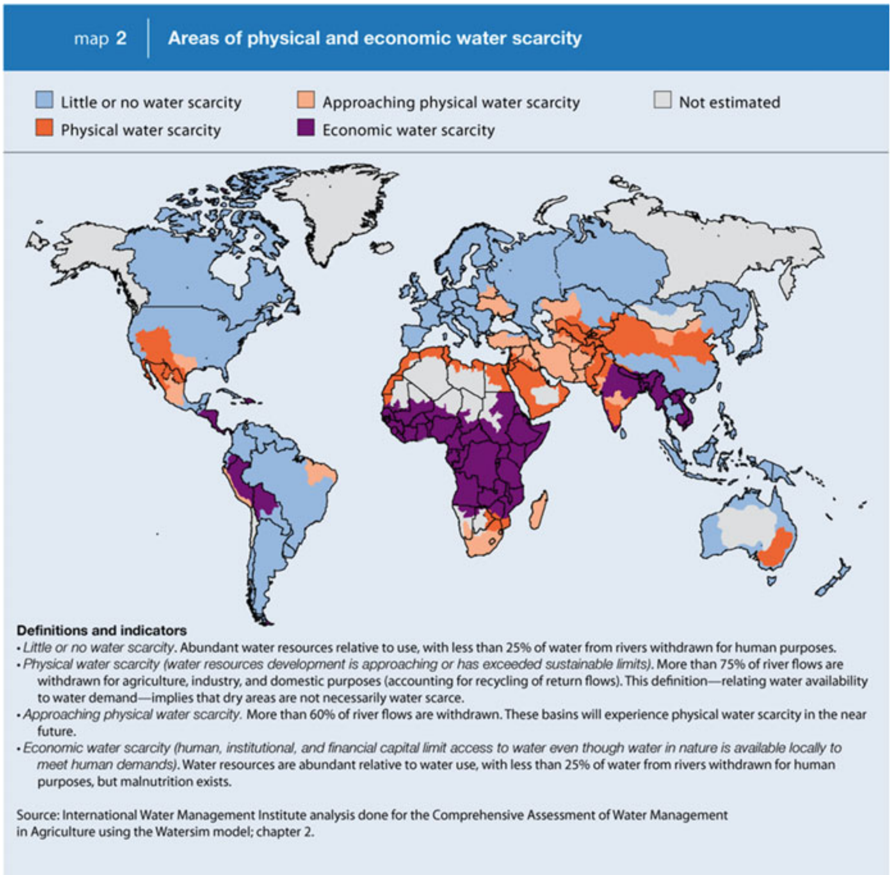

Fig. 17.2 Areas of physical and economic water scarcity (Source: Areas of Physical and Economic Water Scarcity 2008; IWMI 2007)

Table 17.2 World population since 1950 and projection for 2050

Year	Total population (billions)
1950	2.54
1960	3.03
1970	3.70
1980	4.45
1990	5.29
2000	6.12
2010	6.91
2020	7.67
2030	8.31
2040	8.82
2050	9.19

Adapted from UN (2007)

17.2.4 Global Saline Wastelands

Planet earth consists of land surface of about 13.2 × 10^9 ha, of which 7 × 10^9 ha are arable and only 1.5 × 10^9 ha are cultivated (Massoud 1981). Of the cultivated lands, about 0.34 × 10^9 ha (23 %) are saline and another 0.56 × 10^9 (37 %) are sodic. The sodic soils are non-saline and present exchangeable sodium percentage (ESP) on soil exchange complex more than 15. Older estimates (Szabolcs 1989) suggest 10 % of the total arable land to be affected by salinity and sodicity, and extending over more than 100 countries occupying different proportions of their territory. Salt-affected soils occur practically in all climatic belts, from the humid tropics to beyond the polar circle. They can be found in different altitudes, from territories below sea level, e.g., the district of the Dead Sea, to mountains rising over 5,000 m as the Tibetan Plateau of the Rocky Mountains (Szabols 1995). The description of the types of salt-affected soils, causes of formation and hypothetical salinization cycle has recently been reported (Shahid et al. 2010; Shahid and Rahman 2011).

Currently the exact extent of salt-affected soils is unknown due to unavailability of updated information. Based on the FAO/UNESCO Soil Map of the World (1974), Massoud (1977) made an estimate of 880 million ha (M ha) of salt-affected soils, of which 316 M ha are in developing countries. These are the potential areas where land can be leased for food security or alternate energy sources. It is also sensible to lease land in countries where biocapacity is higher than the ecological foot print of consumption. Balba (1980) gave a global estimate of only 600 M ha as salt-affected soils (Africa 30 M ha, Asia 340 M ha, Australia 140 M ha, Europe 1 M ha, North America 26 M ha and South America 60 M ha), these estimates may include soils which are not currently in use and have the potential for biosaline agriculture to meet food demands for the host countries and options for lease for other countries seeking land for agriculture. Recently Pessarakali and Szabolcs (2010) have quoted 954.8 M ha of salt-affected soils (Kovda and Szabolcs 1979) available worldwide (Table 17.3).

Table 17.3 Salt-affected soils of the continents and subcontinents (Kovda and Szabolc 1979)

Continent	Area (million ha)
North America	15.7
Mexico and Central America	2.0
South America	129.2
Africa	80.5
South Asia	87.6
North and Central Asia	211.7
South-East Asia	20.0
Australasia	357.3
Europe	50.8
Total	954.8

17.2.5 Scientific Soil Inventories

The value of scientific soil inventories for rational use of soil resources has long been recognized in the GS. Such soil investigations identify land parcels at the national level for broad land use planning including agriculture activities. In the GS, the Kingdom of Saudi Arabia published a reconnaissance soil map covering the entire Kingdom (Ministry of Agriculture and Water 1985). A similar soil map was completed in the Sultanate of Oman (Ministry of Agriculture and Fisheries 1990). Kuwait was the third country to asses its soils for broader land use planning at scales of 1:100,000 (KISR 1999a) and an area of 200,000 ha was assessed on a semi-detailed level (1:25,000) for irrigated agriculture purposes (KISR 1999b), and the first order soil survey at the farm level (Shahid and Omar 1999). The State of Qatar has completed a detailed survey and published soil and other interpretative maps (Ministry of Municipal Affairs and Agriculture 2005a, b; Scheibert et al. 2005). Recently Abu Dhabi Emirate completed a soil survey at two levels, the extensive for the entire emirate and the intensive survey of 400,000 ha area for irrigated agriculture (EAD 2009).

17.2.6 Land Suitability for Irrigated Agriculture

In the GS the soil survey results were evaluated for the suitability of irrigated agriculture using the FAO framework for land evaluation (FAO 1976) for local food production, to be self sufficient in basic agricultural commodities. However, the results are not encouraging as only small areas have been found suitable for irrigated agriculture (arable land). The above reports show, in Saudi Arabia only 13.8 % of the survey area is suitable for large-scale irrigation farming; in Oman (7.07 %), Kuwait currently 2.71 % area is under agriculture and about 35 % area has the potential for irrigated agriculture (KISR 1999a), Abu Dhabi emirate (5.44 %) area is highly-moderately suitable for irrigated agriculture (EAD 2009), in the State of Qatar such an area is less than 4 % (Ministry of Municipal Affairs and Agriculture 2005a, b).

17.2.7 Arable Land

Summary of arable land in the Arab countries by regions is shown in Fig. 17.3, which clearly illustrates that arable land per capita in the Arab region has been continuously declining since 1961. Such a decline is due to hot climatic conditions and land degradation that has declined the resource capacity for agriculture production since 1961. As of 2003 the GS have less than 0.15 ha arable land per person. This shows, currently, GS has insufficient arable land to meet food demand of its population.

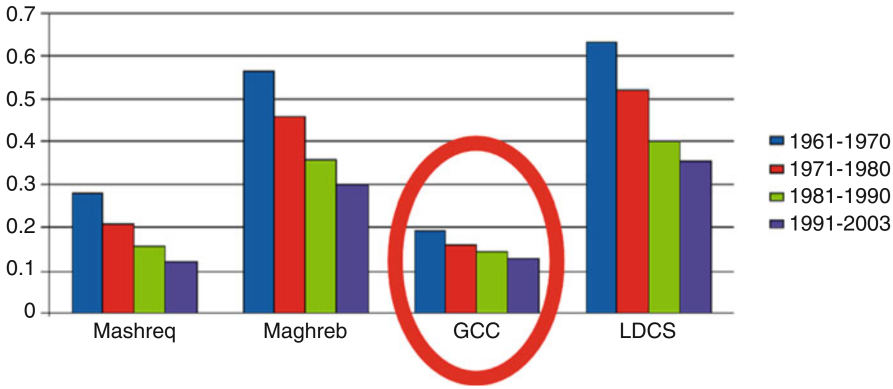

Fig. 17.3 Arable land (in hectares) per capita (1961–2003) (Source: Adapted from World Bank)

17.2.8 Ecological Footprint

Ecological Footprint (EF) analysis measures human demand on nature. It compares human consumption of natural resources with planet Earth's ecological capacity to regenerate them. The EF is a resource accounting tool that helps countries understand their ecological balance sheet and gives them the data necessary to manage their resources and secure their future. In 2007, global humanity's total EF was 18 billion global ha (gha) with world population at 6.7 billion people, the average person's footprint was 2.7 gha, with 11.9 billion gha biocapacity (1.8 gha per person). Thus, it is apparent that humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste (Table 17.4). Moderate UN scenarios suggest that if current population and consumption trends continue, by the 2050s, we will need the equivalent of more than two Earths to support us (Fig. 17.4), and of course, we only have one. This means it now takes the Earth 1 year and 6 months to regenerate what we use in a year, and in 2050 more than 2 years (Ewing et al. 2010).

The overexploitation of earth necessitates saving ecological assets for future generations. Many countries are using more resources than they are generating and hence they are ecologically deficit countries and depend heavily on resources from other countries through food imports. If these are poor developing nations then the implications of ecological deficits can be devastating, leading to resource loss, ecosystem collapse, debt, poverty, famine and war. Currently more than 35 nations are engaged directly with EF analyses for better management of resources. Seventeen nations have completed reviews of the Footprint and Japan, Switzerland, UAE (Gulf State), Ecuador, Finland, Scotland and Wales have formally adopted this methodology.

The Ecological Footprint is measured in global hectares (gha). The gha is a productivity weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The Biocapacity is the capacity of the ecosystem to produce useful biological materials and to absorb waste

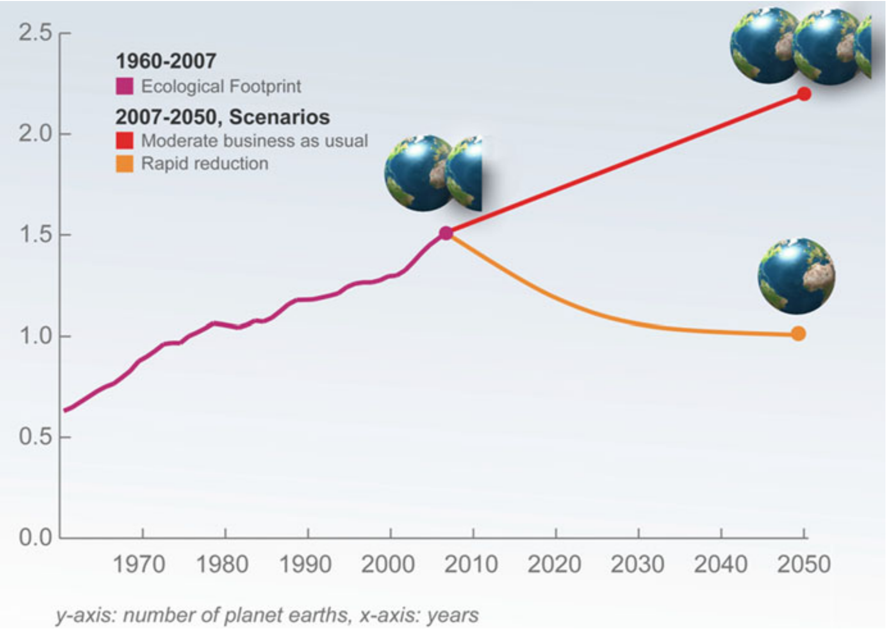

Fig. 17.4 Number of Earth Planets required by 2050 to feed nine billion peoples (Source: Ewing et al. 2010)

materials generated by humans, using current management schemes and extraction technologies. The gha is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a gha of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as 1 ha of cropland. As the world bioproductivity varies slightly from year to year, accordingly the value of a gha changes slightly from year to year. Reader is referred to Ewing et al. (2010) for more information regarding the subject matter.

17.2.9 Ecological Creditors and Debtors

Today, more than 80 % of the world's population lives in countries that use more resources than what is renewably available within their own borders. These countries rely for their needs on resource surpluses concentrated in ecological creditor countries, which use less biocapacity than they have. Recently, Ewing et al. (2010) has reported ecological footprint and biocapacity of high-income 36 countries, including from GS (Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates) and these are shown in Table 17.4.

Table 17.4 The world, Gulf States (high-income) ecological footprint, biocapacity and the difference

Country	Population (millions)	Ecological footprint of consumption (gha per person)	Biocapacity (gha per person)	Nominal difference between EF and biocapacity (gha per person)	Percentage difference between EF and Biocapacity
World	6,670.80	2.70	1.78	0.92	51.70
Kuwait	2.85	6.32	0.40	5.92	1,580.00
Oman	2.73	4.99	2.14	2.85	233.18
Qatar	1.14	10.51	2.51	8.00	418.73
Saudi Arabia	24.68	5.13	0.84	4.29	610.71
United Arab Emirates	6.25	10.68	0.85	9.83	1,256.47

Adopted and modified from Ewing et al. (2010)

Table 17.4 shows all reported GS countries use more resources than are generated; the deficit is compensated through food importing from other countries. According to Ewing et al. (2010) in the GS, the UAE has the highest ecological footprint, the EF trend Ewing et al (2010) in the GS, the UAE has > Qatar > Kuwait > Saudi Arabia > Oman, however, the trend of percent deficit between EF and biocapacity is Kuwait > UAE > Saudi Arabia > Qatar > Oman. The data from Bahrain is currently not available.

17.2.10 Gross Domestic Product and Natural Reserves

The GS has no foreign exchange limitation for food imports. The GS region has also benefitted immensely from the recent sharp increase in oil prices. The increase in the hydrocarbon sector resulted in lifting real GDP in the GS by around 5.5 % in 2010–2011 compared with 5.2 % in early 2010. The collective nominal GDP of GS up by almost US$133 billion in 2010 and is expected to rise in 2011. The GS nominal GDP is expected to hit US$ 1,010 billion in 2011. The GS has almost 1 quarter of the world's natural gas proven reserves. Of the total world natural gas reserves, Qatar shares 14.9 %, Saudi Arabia 3.9 %, Kuwait 0.9 %, UAE 3.5 %, while Oman has made natural gas the chief focus of its diversification and economic growth strategy. In 2008 the percentage contribution of agriculture to GDP in GS was less than 1 % (Bahrain, Kuwait, Qatar), and 2.0, 2.8 and 3.9 % in Oman, UAE and Saudi Arabia respectively. Similarly, the percentage of the population engaged in agriculture varies in different countries e.g., Qatar (0.8 %0), Bahrain (1 %), Kuwait (1.1 %), UAE (3.2 %), Saudi Arabia (5.5 %), and Oman (29.2 %).

17.2.11 Food Import Dependency and Food Security

Despite the GS being capital rich nations, the GS face challenges regarding sustainable use of natural resources, combating desertification and enhancing local food production. In addition to poor existing soil and water resources and harsh climatic conditions, it is projected that the GS will be impacted greatly by climate change through a rise in temperature, decline in rainfall and increase in evapotranspiration (Shahid and Taha 2010). Given these existing and predicted challenges, it is apparent that it would be hard for the GS to achieve food security locally unless there are considerable technological innovations in agriculture research to boost production.

Figure 17.5a shows that almost all countries in the world are importing food to various extents based on their local production and food demands. All GS countries are net food importers, and it is apparent that the GS are importing more than 70 % (Fig. 17.5a), and currently even more than 90 % (Fig. 17.5b). The UAE imports 85 % of its food (Daniel 2011). In the GS the total bill for food imports ballooned from US$8 to US$20 billion from 2002 to 2007 (GRAIN 2008; Daniel 2011). The GS have moved quickly to extend control over food-producing land abroad (Daniel 2011).

Food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Important dimensions of food security are: food availability, food access, utilization (state of nutritional well-being), affordability and stability. Food importing has various aspects of benefits and impact on economies, it gives an opportunity to trade with other countries and build up relationships, however, long term food importing raises some concerns: significant financial obligations – capital flow from food importing counties can affect national economies, lack of control on food quality – production, high risks of food insecurity during wars and when food import demand increases.

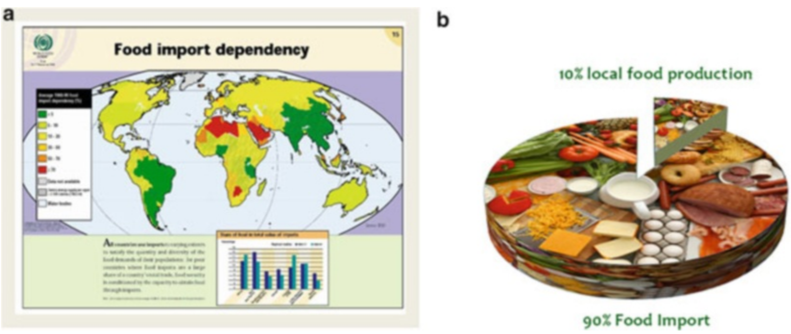

Fig. 17.5 Food import dependency and actual food import by Gulf States. (**a**) Worldwide food import dependency. (**b**) Share of Gulf States to total food import

Water scarcity, poor soil resources and the hyper-arid environment lead the GS to have a high deficit between EF of consumption and Biocapacity (Table 17.4), and thus it is highly likely that the GS (capital rich and food insecure nations), to meet the demand of continuing population growth, will continue to import food and may be seeking new options of food security and perhaps will be in the forefront of new investments in farmland abroad.

While the food is imported, at the same time the countries are also importing virtual (or embodied) water. This is a measure of the total water used in production of goods or services, e.g., 1 kg of wheat requires about 1,000 l of water, and 15,500 l of water is required to produce 1 kg of beef (D'Silva 2011). The concept was initially used to illustrate the advantages to water scarce nations of trade with other nations, rather than attempting to produce all goods locally.

17.2.12 Farmland Investment in Developing Countries

There are many ways by which economically prosperous but food insecure nations can achieve food security, like intensification in local food production using high-tech (rationale use of soil resources, modern irrigation systems, protected agriculture, water conservation, sector wide water reforms, use of alternate water sources); continuing food import; outsourcing food production to countries which have comparative advantage for agricultural expansion; and through creation of GS-FOOD RESERVES to be used in case of emergency and lasting for at least 2 years. In addition to the above options, it is likely that GS may be in the forefront of new investments in farmland abroad. However, the purchase, lease or acquisition of land in the poor developing countries by foreign investors for sources of alternative energy and food crops has led to the so called "***land grab***".

17.2.13 Main Driving Forces for Land Lease Abroad

There are three main driving forces for land lease abroad; (1) to secure food supply by increasingly food-insecure nations; (2) the surging demand for agrofuels and other alternate energy sources and; (3) the sharp rise in investment in both the land market and the soft commodities market.

17.2.14 Major Concerns of Land Lease

The major concerns of Activists, Researchers and Environmentalists are; (1) private land investments only increase monoculture-based, export-oriented agriculture, arguably jeopardizing international food security; and (2) domestic to foreign control over crucial food-producing lands. Acquisition of farmlands in such resource-poor countries may provoke food insecurity. If land lease is the potential way to meet food demand, then it is sensible to lease land where there are resource surpluses (abundant soil and water resources) concentrated in ecological creditors' countries, which currently do not utilize their full biocapacity and where production cost is lower. However, this is not the present scenario and there have been land deals in poor developing countries by foreign investors (von Braun and Meinzen-Dick 2009) eg for biofuels (Congo, Ethiopia, Mozambique, Tanzania, Zambia), Rice (Angola, Cambodia, Cameron, Indonesia, Mali, Mozambique, Tanzania,), Wheat (Egypt, Sudan), Maize (Madagascar) and general agriculture projects (Africa, Malawi, Nigeria, Pakistan, Turkey, Ukraine, Vietnam) etc. Perhaps such deals are a global re-alignment of political economic relations through diverse trajectories and neo-liberalisation.

17.2.15 Gulf Deals of Land Leasing Abroad

There have been reports (von Braun and Meinzen-Dick 2009) of Gulf deals for farmland abroad e.g., **Saudi Arabia** (Sudan-wheat, vegetables, animal feed; Indonesia-rice; Egypt-barley, wheat, livestock feed; World-agriculture projects); **UAE** (Sudan-corn, alfalfa, wheat, potato, beans; Pakistan-agriculture; Ethiopia-tea); **Qatar** (Kenya-fruits, vegetables; World-food and energy; Vietnam-agriculture); **Kuwait** (Cambodia-rice); **Bahrain** (Philippine-agroforestry; Turkey-agriculture); Dubai World Trading Company (Ethiopia-tea).

17.2.16 FAO-IFAD-IFPRI Perception of Land Grab by Gulf States

The land lease (land grab) trend has come under heavy scrutiny since mid-2008. On the one hand, investment in agricultural land is thought to be an answer for boosting food production in a world plagued by food shortages; on the other hand, many claim that this large-scale, private-sector-led approach conflicts with the urgency of increasing domestic food supplies in the world's poorest and most vulnerable countries.

The FAO Director General Jacques Diouf, while having clearly expressed his concern about the potential consequences of swift land grabbing on political stability, has said "he supports the proposed Gulf food deals as a means of economic development for poor countries. If the deals are constructed properly, he said, they have the potential to transform developing economies by providing jobs both in agriculture and other supporting industries like transportation and warehousing" (Coker 2008; *cf* Daniel 2011).

Similarly the President of the International Fund for Agricultural Development (IFAD) expressed hope for possible development opportunities through land purchases. "*When such deals take into account interests of both parties they help increase agricultural production in developing countries, provide jobs, boost export and bring in new technologies to improve farm efficiency there*" (Kovalyova 2009; *cf.* Daniel 2011). Despite calls from several organizations including the UN for an international code of conduct for land acquisition, most of the land deals to date lack transparency and offer little or no concession to small farmers. The IFPRI calls for a code of conduct both for foreign investors and the host countries in order to protect the interests of small farmers, as well as address environmental concerns on biodiversity and water and land resources stemming from the impact of large-scale farmland investments. No matter how convincing the claim that the global land grab will bring much-needed agricultural investment to poor countries, evidence shows there is simply no place for the small farmer in the vast majority of these land grab situations (Daniel 2011).

17.2.17 Win-Win Scenario for Both Investors and Host Countries

Farmland investment in developing countries can be a potential "*win-win*" situation in which *food-insecure* nations increase their access to food resources and "*host*" nations benefit from investments in the form of improved agricultural infrastructure and increased employment opportunities. There are, however, strengths; weakness, opportunities and threats (SWOT) in such an approach. In the authors' opinion if the foreign investors acquire marginal lands (saline land resources) which are set aside and currently are either not under production or cannot be brought into production due to poor economic resources of the host countries (refer to Table 17.3), and the investors bring them into production, with the condition that the prime agricultural lands are left for the host country, and this practice does not upset the local market, farmers rights and food policies, and arrangements are properly negotiated, local manpower receive training on high-tech in agriculture production, practices are sustainable, and benefits are shared by the investors and the host countries, it is only then the investment abroad has a positive case and both the investors and the host countries are in a win-win situation. Under such circumstances and choices ICBA can significantly support Gulf States in growing salt-tolerant crops (Shahid et al. 2011; Shahid and Rahman 2011) in farmland acquired abroad and through the reclamation of salt-affected lands, paving the way forward for food security. If this scenario is widely supported, then there are worldwide opportunities to lease marginal lands to achieve food security by GS countries.

17.2.18 Biosaline Agriculture and ICBA

In 1999 the International Center for Biosaline Agriculture (ICBA) was established in Dubai to conduct biosaline agriculture research and implement in Islamic Development Bank (IDB) member-countries including the Gulf States (GS).

Since ICBA's inception in I999 and until 2009, ICBA's mission was to demonstrate the value of saline water resources for the production of environmentally and economically useful plants and to transfer the results to national research services and communities regionally and globally. In the second strategic plan (2009–2014) ICBA is focusing on helping water-scarce countries improve productivity, social equity and environmental sustainability of water use through an integrated water resource systems approach, with special emphasis on saline and marginal quality water. ICBA is unique in the world as it is full time involved in Biosaline Agriculture activities.

17.2.19 Agricultural Production Systems and Marginal Quality Waters

ICBA is contributing to various Research and Development activities related to the use of marginal quality waters (saline/brackish waters) in developing agriculture production systems and introducing to various NARS (National Agricultural Research Systems) and through building capacity of national manpower in many countries (Bangladesh, Bahrain, Egypt, Iran, Jordan, Kazakhstan, Kuwait, Libya, Morocco, Niger, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Tunisia, Turkmenistan, UAE, Uzbekistan, Yemen etc.). ICBA achievements over the past 10 years have been documented by Shahid et al. (2011). ICBA business in biosaline agriculture is based on:

- Collection of germplasm from around the world and screening at ICBA.
- Identification of new and improved salt-tolerant germplasm (conventional crops and halophytes) to sustain ecosystem productivity.
- Developing alternative production systems and technologies to improve productivity in marginalized environments.
- Developing low-cost technologies for low-quality water-use by small scale farmers.
- Promoting policies, legal and institutional frameworks for sustainable resource management.
- Establishing stronger partnerships with NARS to test and adopt new technologies for ecosystem resilience.
- Provide training (capacity building) to staff from National Agricultural Research Systems (NARCS) in Islamic Development Bank (IDB) member countries.

17.3 Conclusions and Recommendations

The Gulf States are facing a number of constraints (hyper-arid climate, scarce water resources and arable lands, poor soils, high ecological footprint of consumption, climate change impact) limiting sufficient local food production to meet the food demand of the existing and continuing growing population. Therefore, it is believed that food import by GS is likely to continue. This is the time that GS must act urgently to improve food security and therefore need a multi-pronged approach including expansion of future agriculture activities on soils suitable for irrigated agriculture based on scientific soil information, protection and management of the limited water resources, efficient use of water to increase production, exploring alternate water sources (treated waste water) for agriculture, increasing investment in agricultural research and technological innovation, developing a comprehensive strategy including creation of regional food reserves sufficient for at least 2 years, leasing marginal lands and bringing then into production through reclamation and biosaline agriculture, or leasing prime land in resource surpluses concentrated in ecological creditor countries, which uses less biocapacity than they have. The above are the basic recommendations which can be viewed by GS as a whole and the individual countries where appropriate on case by case basis.

Acknowledgements The support of ICBA management for approving the mission to attend ICCAFFE 2011 Agadir Morocco May 19–21, which made this Chapter possible for publication, is highly acknowledged. Thanks are also extended to IWMI, UNEP/GRID, Global Footprint Network for their flexibility to use maps for publication. These maps get due credit and they are properly cited as recommended.

References

Areas of Physical and Economic Water Scarcity. (2008). *UNEP/GRID-Arendal Maps and Graphics Library*. Retrieved 07:43, July 31, 2011, from http://maps.grida.no/go/graphic/areas-of-physical-and-economic-water-scarcity

Balba, A. M. (1980). *Minimum management programme to combat world desertification*. UNDP Consultancy Report on Advances in Soil Water Research, Alexandria, Egypt.

Charles, H., Godfray, J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas S. M, & Toulmin, C. (2010). Food security: The challenge of feeding 9 Billion People. *Science Express Review*, 12. Sciencexpress/www.sciencexpress.org. Accessed 28 Jan 2010.

Coker, M. (2008, September 10). UN Chief warns on buying farms. *The Wall Street Journal*.

Daniel, S. (2011). Chapter 2: Land grabbing and potential implications for world food security. In M. Behnassi, S. A. Shahid, & J. D'Silva (Eds.), *Sustainable agricultural development-Recent approaches in resources management and environmentally-balanced production enhancement* (pp. 25–42). Dordrecht/Heidelberg/London/New York: Springer.

D'Silva, J. (2011). Food price rises and the meat connection. *Newsletter of the World Forum on Climate Change Agriculture and Food Security (WFCCAFS), 1*(2), 2.

EAD. (2009). *Soil survey of Abu Dhabi Emirate*. Environment Agency Abu Dhabi. 5 Vols. Abu Dhabi: Environment Agency – Abu Dhabi.

ESCWA. (2007). UN-Economic and Social Commission for Western Asia.

Ewing, B., Moore, D., Goldfinger, S., Oursler, A., Reed, A., & Wackernagel, M. (2010). *The ecological footprint atlas 2010* (p. 111). Oakland: Global Footprint Network.

FAO. (1976). *A framework for land evaluation* (FAO Soils Bulletin No. 32). Rome: Food and Agriculture Organization.

Dougherty, W. W., Fencl, A., Elasha, B. O., Swartz, C., Yates, D., Fisher, J., et al. (2009). *Climate change impacts, vulnerability and adaptation* (p. 197). Abu Dhabi: Environment Agency – Abu Dhabi.

GRAIN. (2008, October 24). *Seized! The 2008 land grabbers for food and financial security*. http://www.grain.org/article/entries/93-seized-the-2008-landgrab-for-food-and-financial-security. Last accessed 9 Apr 2013.

IWMI. (2007). *Areas of physical and economic water scarcity. Appears in IAASTD-International assessment of agricultural science and technology of development*, published in 2008. http://maps.grida.no/go/graphic/areas-of-physical-and-economic-water-scarcity Last Accessed 30 July 2011. Link to website http://www.agassessment.org/

KISR. (1999a). *Soil survey for the State of Kuwait – Vol. II: Reconnaissance survey*. Adelaide: AACM International.

KISR. (1999b). *Soil survey for the State of Kuwait – Vol. IV: Semi-detailed survey*. Adelaide: AACM International.

Kovalyova, S. (2009, April 19). *UN agencies see "win-win" farmland deals*. Reuters.

Kovda, V. A., & Szabolcs, I. (1979). Modelling of soil salinization and alkalization. *Agroké mia és Talajtan, 28*(Suppl), 1–208, Budapest.

Massoud, F. I. (1977). Basic principles for prognosis and monitoring of salinity and sodicity. In *Proceedings of the international conference on managing saline water for irrigation* pp. 432–454). Lubbock, TX: Texas Tech University, 16–20 Aug 1976.

Massoud, F. I. (1981). *Salt-affected soils at a global scale and concepts of control* (Technical Paper, 21 p). Rome: FAO Land and Water Development Division.

Millennium Ecosystem Assessment (MEA). (2005). *Ecosystems and human well-being: Current state and trends*. Washington, DC: Island Press.

Ministry of Agriculture and Fisheries. (1990). *General soil map of the sultanate of Oman*. Muscat: Ministry of Agriculture and Fisheries.

Ministry of Agriculture and Water. (1985). *General soil map of the Kingdom of Saudi Arabia*. Riyadh: Ministry of Agriculture and Water.

Ministry of Municipal Affairs and Agriculture. (2005a). Soil classification and land use specifications for the State of Qatar. Phase one report. Vol. I: Soil survey report; Vol. II: Technical data.

Ministry of Municipal Affairs and Agriculture. (2005b). Soil classification and land use specifications for the State of Qatar. Phase two report.

Pessarakli, M., & Szabolcs, I. (2011). Chapter 1: Soil salinity and sodicity as particular plant/crop stress factors. In M. Pessarakli (Ed.), *Handbook of plant and crop stress* (pp. 3–21, 496 p.). Boca Raton/London/New York: CRC Press/Taylor and Francis Group. ISBN 978-1-4398-1396-6.

Scheibert, C., Stietiya, M. H., Sommar, J., Abdalla, O. E. S., Schramm, H., & Al Memah, M. (2005). *The atlas of soils for the state of Qatar*. Doha: Ministry of Municipal Affairs and Agriculture.

Shahid, S. A., & Omar, S. A. S. (1999). *Order 1 soil survey of the demonstration farm sites with proposed management* (p. 144). Kuwait: Kuwait Institute for Scientific Research. ISBN 0 957700369.

Shahid, S. A., & Rahman, K. (2011). Chapter 2: Soil salinity development, classification, assessment and management in irrigated agriculture. In M. Pessarakli (Ed.), *Handbook of plant and crop stress* (pp. 23–39). Boca Raton/London/New York: CRC Press/Taylor and Francis Group.

Shahid, S. A., & Taha, F. K. (2010). *Climate change impact outlook – Mitigation and adaptation efforts in the Arab region*. Presentation at international conference on impact of climate change on agriculture and biodiversity in the Arab region. State of Kuwait, November 30–December 2, 2010.

Szabolcs, I. (1989). *Salt-affected soils* (p. 274). Boca Raton: CRC Press.

Szabolcs, I. (1995, November 6–10). Global overview of sustainable management of salt-affected soils. In *Proceedings of the international workshop on integrated soil management for sustainable use of salt-affected soils* pp. 19–38). Diliman, Quezon City, Manila: Bureau of soils and water management.

UN. (2007). *Department of Economic and Social Affairs, Population Division (2007). World population prospects. The 2006 Revision, Highlights* (Working Paper No. ESA/p/wp:202), New York.

von Braun, J., & Meinzen-Dick, R. (2009, April). "Land Grabbing" by foreign investors in developing countries: Risks and opportunities (IFPRI Policy Brief 13, 9 p.).