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The Camel
From Tradition to Modern Times

A Proposal Towards Combating Desertification via the Establishment of Camel Farms Based on Fodder Production From Indigenous Plants and Halophytes

UNESCO DOHA

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Oryx with its calve in Qatar. **Photo:** Henning Schwarze

Protected desert area in Qatar. **Photo:** Marc Breulmann

Zygophyllum qatarense (Qatar). **Photo:** Nicholas Pilcher

Mangroves in Khor Kalba (UAE).

Photo: Benno Böer

Modern Camel Farm (UAE).

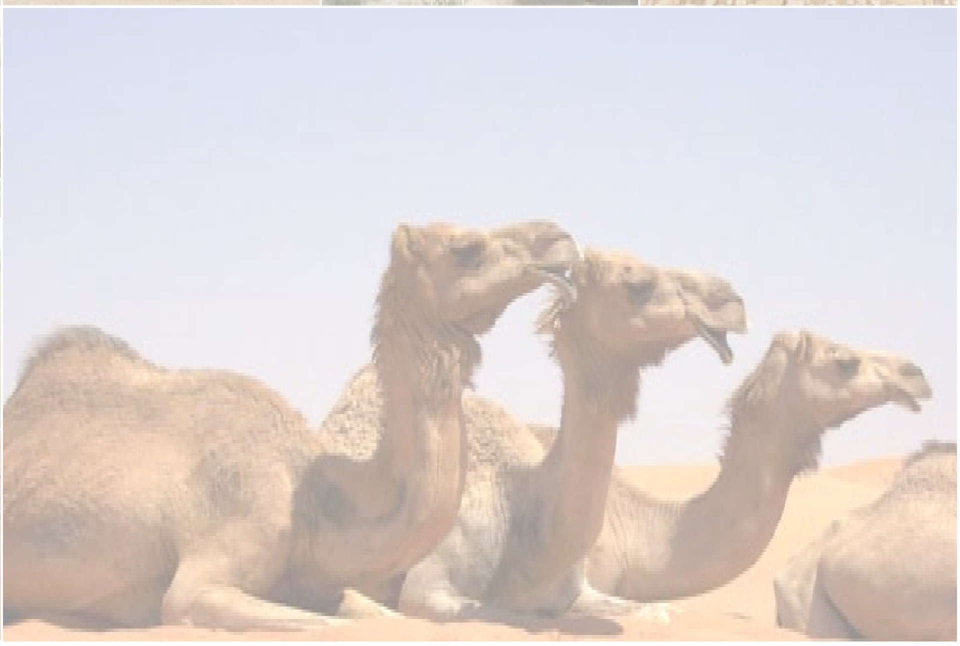
Photo: Ulrich Wernery

Growth of *Pennisetum divisum* after seeks weeks.

Photo: Gary Brown

Dried soil.

Photo: Nicholas Pilcher



A group of camels enjoying the sun; **Photo:** David Gallacher

Fig.1: A camel bull in the United Arab Emirates.

Photo: David Gallacher

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The traditional "hema" system was harsh, however it was sustainable. The Bedouin could only live their way-of-life because they had camels, which they greatly respected as an inseparable part of their cultural heritage.

General Facts about Camels & their Biology

- The family Camelidae includes the Bactrian (*Camelus bactrianus*; two humps), dromedary camel (*Camelus dromedarius*; one hump), as well as llamas, alpacas, guanacos and vicunas.
- Gestation period is about 13 months; gives birth to 8 - 10 calves in its breeding life of around 25 - 30 years.
- Producing first milk at the age of 4 - 5 years.
- Grazing on most plants and trees as high as 3 m above ground.
- Camels have a higher salt requirement than other livestock.
- Eat halophytes (salt tolerant plants), thorny, bitter and toxic plants that are avoided by other herbivores.
- In the central Asian desert a Bactrian species was discovered which survives by drinking brackish water in the sabkha.

(Legel 1990, Farah *et al.* 2004)

Foreword

Most parts of the Arabian Peninsula and particularly the Arabian Gulf countries are characterized by extreme aridity, which is manifested by adverse environmental conditions, leading to fragile ecosystems. This fragility is compounded by overgrazing and other unsustainable activities. The adoption of conservation measures namely, the "*hema*" system combined with traditional pastoralism has allowed people of the desert to live in this harsh environment for thousands of years maintaining themselves solely from their herds and from natural plant resources. Traditional herding patterns have changed significantly over the last forty to fifty years, resulting in a considerable decline of natural rangelands. Also an increase in livestock numbers, which is attributed to various factors, including increases in wealth, ready availability of water tanks, and the practice of moving stock to any available natural fodder lead to major changes in herding patterns. Consequently it is estimated that 80-90% of rangelands are severely degraded with most of its palatable perennial grasses and shrubs dramatically reduced.

In view of this situation it appears that it is important to reverse the degradation processes through adopting a strategy for natural resource management systems. This strategy should be holistic and promote self-sufficiency of the desert people and provide means that ecosystems may be fully utilized on a sustainable basis.
It is well established that camels, in comparison to other livestock, are perfectly adapted to arid environments. Nowadays the camel densities are exceeding the ecological carrying capacity in various parts of the Arabian Peninsula, where the camel continues to be an important source of meat, milk and several other products.

The present novel proposal of establishing "Camel Farms" provides an innovative solution to combat desertification and hence it may present a valuable approach to relieve natural areas from the ongoing degradation due to overgrazing. Moreover, it will hopefully provide a model that might encourage camel owners to move the increasing camel herds from degraded rangelands and adopt this innovative approach of intensive farming for the production of various valuable commercial products. It will also assist in the process of reversing desertification and restoring desert ecosystems.

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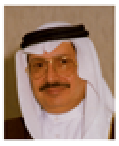

Fig. 2: A female camel with its few-week old calf (Qatar).

Photo: Marc Breulmann

Abstract

The United Nations Educational, Scientific, and Cultural Organization (UNESCO), has made aware the threatening yet continuing effects of desertification. In addition to causing land degradation, desertification has an immense impact on the ecological system. The International Year of Deserts and Desertification in 2006 (IYDD) has raised awareness that time and money are needed to focus on sustainable development. Enhanced knowledge of causes of desertification and developing sustainable solutions are essential to enable the recovery of desert ecosystems. Procedures need to be developed to stop the progress of land degradation and to develop major steps in conservation and sustainable management of land and water resources.

In the Arabian Peninsula, rangeland biodiversity and animal production exist in a delicate balance. Increases in the livestock population has meant that the native plant biodiversity of the Arabian Peninsula, which comprises over 3500 species, is being rapidly depleted by grazing, particularly the palatable species. Over 90% of the total land area now suffers from some form of desertification, and 44% is severely or very severely degraded.

Camel densities that exceed ecological carrying capacity have been shown by many researchers to be a major threat to desert ecosystems. Reduced camel numbers on open rangeland could redress desertification by allowing vegetation to recover from overgrazing. A prototype Camel Farm should encourage owners to move most camels from open range into intensive farming. Initiating Camel Farms, where camels are fed on native desert- or salt tolerant plants may help further the restoration process of the ecosystem.

Indigenous palatable plants, as well as palatable halophytes may be grown on existing farms that produce fodder commercially, generating a more sustainable method of fodder production, by reducing the amount of freshwater irrigation needed. Desert plants and halophytes consume less freshwater and can be used as camel fodder. Exotic species such as of Rhodes-grass (*Chloris gayana*) and alfalfa (*Medicago sativa*) are currently being grown as fodder in order to supplement the shortfall of palatable rangeland plants. Rhodes-grass and alfalfa consume high volumes of water, (up to 48.000 m^3/ha/yr). Therefore groundwater reserves have fallen dramatically leading to increasing soil salinity levels.

Indigenous grasses that are adapted to the local climatic conditions are known to respond positively to very small amounts of irrigation. There is an urgent need to collect and conserve these grasses and evaluate their potential as fodder crops under systems with minimal fresh water irrigation for desert plants or with water of relatively high salt content.

The rate of restoration/rehabilitation of desert rangelands to their natural condition can be demonstrated in controlled studies in the Camel Farm and can be supported by studies in the open desert. The outcome of these studies will be a more stable ecosystem and enhancement of the desert environments.

The three main expected results of the studies are:

1. **Reverse desertification and restore desert ecosystems.**
2. **Viable production of commercial farm products.**
3. **Improvement of water use efficiency for fodder production.**

In this proposal the UNESCO will explain the effect of desertification and overgrazing to desert environments and suggest a possible solution (Camel Farm) to restore these ecosystems to their natural conditions. Furthermore the proposal will demonstrate the overall value of commercial products produced in the Camel Farm and demonstrate the reduction of fresh water usage for fodder production.

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1. Background

During traditional times of nomadic husbandry the Bedouins and their camels lived in a harmonious, symbiotic relationship with their environment. Camels provided a wide range of useful products such as milk, meat, wool and leather and were basically used for transportation. They were regarded as a "Gift from God" (Gilespie 2006). Generally the Bedouins evolved elaborate ways of living off their fragile rangelands without over-exploiting them. The Bedouins guided their camel herds to good grazing pastures. They knew that when heavy rain penetrates the sand for more than one meter depth, it would provide good grazing conditions for up to three years. A balance existed between the components of the rangeland system, so that the traditional nomadic husbandry had only a slight negative influence on the desert ecosystem (Al-Rowaily 1999; Olsvig-Whittaker *et al.* 2006). At that time the overall vegetation densities rarely ever fell below ten percent of land cover (Barth 1999).

For times of prolonged drought, the Bedouins developed the "*hema*" system. It consists of protecting certain areas of common tribal pastures from grazing for a fixed period.

All of this changed during the 20th century, when land degradation increased through rapid social and economic changes (Böer 1997). Extensive oil exploration led to a rise of human population and concomitant urban development. Such development is still proceeding today at an increasing rate. Over time, traditional husbandry was transformed into a commercial range system. This shift from nomadic to sedentary farming led also to an increasing demand on natural fossil water resources because the number of camels and the fresh water irrigation of camel fodder plants increased. Grazing areas of the natural vegetation remained unchanged.

The traditional, well functional, "*hema*" method was converted into a non-sustainable system associated with an overexploitation of the desert rangelands. Well vegetated rangelands were transformed into deserts of 0-1 % vegetation cover and camels gradually replaced the populations of other native large herbivores, such as oryx and gazelles (Barth 1999).

Landscapes were subjected to man-made desertification and water consumption exceeded the rate of renewal. In many areas, the desert cannot recover even if there would be enough rainfall. However still today good examples of temporary and permanent "*hema*" methods can be found in The Republic of Yemen (Peacock, pers. comm.).

As the cities grew rapidly, dairy farms for the production of cow milk were established. This, in turn, put additional pressure on limited freshwater resources because large-scale agri-

Fig. 3a: A Camel herd in the United Arab Emirates.

Photo: David Gallacher

culture production of alfalfa and Rhodes grass demanded freshwater irrigation.

1.1 Overgrazing

Although camels are the most suitable domesticated animals for the desert, intensive camel grazing is one of the primary causes of ecological degradation in desert ecosystems with a dramatic reduction of species diversity and densities in the desert environments.
This is a question of quantity. For example over the last 30 years, the camel population in the UAE has doubled, with severe consequences for the environment.

Overgrazing lowers the productivity of ecosystems and reduces the species richness and relative abundance (Böer 1999; Gallacher & Hill 2006 b). Palatable plant species are replaced by unpalatable plants. Livestock grazing also leads to a considerable increase of sand movement. Vegetation cover that normally protects the soil from erosion is reduced. Today livestock grazing affects more than 90 % of the land on the Arabian Peninsula and rangeland degradation takes place (Peacock *et al.* 2003 a; Gallacher & Hill 2006 a).

Fig. 3b: A Camel herd in the United Arab Emirates.

Photo: David Gallacher

1.2 Desertification

The UNCCD (United Nations Convention to Combat Desertification) developed a definition of desertification and presented it at the 1992 Earth Summit:

"Land degradation in arid, semi-arid and sub-humid areas resulting from various factors, including climatic variations and human activities."

Desertification is currently taking place much faster worldwide than ever before. It usually arises from the demands of increasing populations that settle on the land in order to cultivate crops and graze livestock. The major impact of desertification are **loss of biodiversity**, and **loss of productive capacity**, such as the transition from grassland dominated by perennial grasses to land dominated by non-palatable, toxic, thorny or halophyte shrubs. Further key features of desertification include, **loss of soil fertility** and an **increase in aeolian activity** (wind ability to shape the soil surface of ; wind erosion) (Dregne 1986). Unregulated land cultivation often compounds the desertification process since the land is frequently too arid or sandy for normal agricultural uses.

Nowhere is the crisis of top soil loss more acute than in arid lands where the soil is especially fragile. Desertification now affects almost **30%** of the world's total land area, costing about **42 billion USD/year** (Lean 1995). Unfortunately, areas that are undergoing desertification are brought to public attention only after the degradation process is well under way. There is often very restricted information about the previous state of the ecosystem or the rate of degradation available, that makes the efforts for any comparative studies difficult.

Fig. 4: Upper, sun dried soil layer with barely any vegetation in the desert of Qatar.

Photo: Nicholas Pilcher

1.3 The Project

The UNESCO Doha Office offers its assistance for developing a Master plan to establish a **Modern Camel Farm**.

Modern Camel Farms could be a novel contribution to combat desertification. The number of camels in the Arabian Peninsula rangelands must be sginificantly reduced (Gallacher & Hill 2006 b) and overgrazing must be stopped to allow the recovery of desert ecosystems. However the ability to recover for certain areas always depends on the soil and the degree of degradation that has taken place. The recovery is minimal if the degradation has been high. Areas might not recover where the top soil has blown away. In hot environments Camel Farms have several advantages over cow farms:

Cow farms in the Arabian Peninsula require an air-conditioned environment for milk production. Cows can produce 25 liters of milk per day but only in an air-conditioned environment. In natural conditions the milk production would be ~ 5 liters.

Camels, which are indigenous to the Arabian Peninsula and adapted to the hot and dry desert conditions produce four times more milk per day. Therefore camels are far better suited than cattle and small ruminants for animal husbandry in desert areas. Unlike sheep and goats, which clear the entire vegetation cover down to the soil surface, camels take only a few bites from shrubs or trees and then move on. They are true browsers.

The feasibility and success of this new sustainable livestock industry will require strict grazing laws (Le Houérou 2006) as well as a sustainable system for fodder production. Governments are encouraged to allow livestock grazing on rangelands only when it is in tune with the ecological carrying capacity in order to restore the desert ecosystems.

Producing indigenous plants is a more sustainable way of fodder production because the amount of freshwater needed for irrigation can be significantly reduced when compared with Rhodes grass (*Chloris gayana*) and alfalfa (*Medicago sativa*) (Peacock *et al.* 2003 a) (Böer and Peacock presented this idea at an International Conference: "*Promoting Community-Driven Conservation and Sustainable Use of Dryland Agrobiodiversitiy*, Peacock *et al.* 2003 b). Indigenous plants will also have less fertilizer and pesticide requirements which make them more environmentally friendly compared to conventional field-grown fodder.

The importation/production of for example forage crops such as alfalfa and Rhodes grass should be minimized as sources of camel fodder since they are poorly adapted to the conditions of drought, high temperatures and salinity of the desert soils. They also require high amounts of freshwater for irrigation. Sustainable human development via the establishment of Camel Farms will also bring wider socio-economic benefits to the local region. Jobs will be generated in the farm and in the tourism and transport sectors. These Camel Farms will also provide saleable farm products such as camel milk and meat.

1.4 Main Aims

The UNESCO Doha Office intends to support a project to initiate the establishment of a prototype **Camel Farm**, which uses experimental plots to demonstrate the following aspects:

1. **Reverse desertification and restore desert ecosystems.**
2. **Viable production of commercial farm products.**
3. **Improvement of water use efficiency for fodder production.**

The achievement of all these objectives requires the promotion and development of a well organized Master Plan, involving the input of experts and advice from rangeland and camel specialists.

Fig. 5: A Small camel herd in the desert of the United Arab Emirates.

Photo: David Gallacher

Although camels are browsers and do not destroy their habitat if they are kept in low numbers, they currently have a major impact on desertification and biodiversity loss in many camel rearing countries, due to the high number per ha. Therefore, their numbers must be significantly reduced to combat desertification. A wise decision by the government of the UAE some years ago, for example, has banned cows and especially goats and sheep from the desert. They are now kept in closed pens. Camels should follow suit, in tune with the carrying capacity.

2. The Camel

2.1 The Evolution of the Camel

The camelid family belongs to the order *Artiodactyla* (even-toed ungulates) and sub-order *Tylopoda* (pad-footed mammals). They are not ruminants and possess several unique features:
They walk on pads not hooves, do not have horns or antlers, and their red blood cells are oval shaped.

Camelids evolved in North America 50 to 60 million years ago in the Tertiary period. About five million years ago, during the late Miocene period, the Camelidae migrated to northeast Asia over a land bridge, which is now known as the Bering Strait. The Old World Camels (OWC) of today evolved from these early camels, spreading westwards across Asia. They were most widespread during the Pleistocene era, which began around two million years ago, when they reached as far as Eastern Europe, North and East Africa and East Asia. During the great Ice Ages they later died out in some of the areas of their range. When the OWC migrated eastwards after crossing the Bering Strait, the ancestors of the humpless New World Camels (NWC) migrated south over the newly formed Panamanian land bridge and found their niche in the cool, dry mountain areas (altiplano) of South America. The NWC are also known as South American camelids, humpless camelids or small camelids.

There are four different species: **llama** (tame), **alpaca** (tame), **guanaco** (wild) and **vicuna** (wild) (Wernery & Wernery 2002).

All Camelidae have the same number of chromosomes (2x36 = 72 autosomes and one pair of sex chromosomes), and they are phylogenetically related to each other. Therefore, cross breeding (hybridisation) is possible between all species of Camelidae. Most of the camelid spe-

Fig. 6: Hay production for livestock fodder, by using plant species which consume high volumes of fresh water (United Arab Emirates).

Photo: Marc Breulmann

Country	Area km²	Human population (thousands)	Camel population (thousands)	Camel density (no./km²)
AFRICA				
Algeria	2 381 741	24 960	135	0,06
Burkina Faso	274 200	8 996	5	0,02
Chad	1 284 000	5 678	540	0,42
Djibouti	23 200	409	59	2,50
Egypt	1 001 450	52 426	190	0,20
Ethiopia	1 221 900	49 240	1 080	0,88
Kenya	580 370	24 031	810	1,40
Libya	1 759 540	4 545	193	0,11
Mali	1 240 190	9 214	241	0,19
Morocco	446 550	25 061	230	0,10
Mauritania	1 025 520	2 024	820	0,80
Niger	1 267 000	7 731	420	0,33
Nigeria	923 770	108 542	18	0,02
Senegal	196 720	7 327	15	0,08
Somalia	637 660	7 497	6 855	10,75
Sudan	2 505 810	25 203	2 800	1,12
Tunisia	163 610	8 180	187	1,14
ASIA				
Afghanistan	652 090	16 557	265	0,40
India	3 287 260	853 094	1 450	0,44
Iraq	438 320	18 920	250	0,13
Iran	1 648 000	54 607	27	0,02
Israel	20 770	4 600	10	0,48
Jordan	89 210	3 288	15	0,17
Kuwait	17 820	2 039	6	0,34
Oman	212 460	1 502	87	0,41
Pakistan	796 100	122 626	990	1,24
Qatar	11 000	368	24	2,18
Saudi Arabia	2 149 690	14 134	780	0,19
Syrian Arab Republic	185 180	12 530	5	0,03
United Arab Emirates	83 600	1 589	250	1,37
Yemen	527 970	11 687	144	0,27

Table 1: General data, showing the occurrence of camels in Africa and Asia. It shows the size of the country (area/km²), human & camel population (thousands) and the camel density (no/km²). Source: FAO. Production Yearbook 1990, No. 44. Modified by Marc Breulmann.

cies have been integrated into, and play a very important role in the lives of indigenous people. There are approximately 20 million OWC, of which two million are domesticated Bactrians. There is also a small population of wild Bactrian camels, numbering only a few hundred, which are highly endangered. They live in the Gobi deserts of China and Mongolia.

2.2 Camelid Physiology

The camelid family are well adapted to their respective environments. The OWC to the harsh and hot deserts of Africa, Arabia and Asia, and the NWC to the high altiplano and bush areas of South America. They have developed remarkable features which guarantee their survival in such inhospitable habitats.

Under very hot conditions, the dromedary camel (*Camelus dromedarius*) may drink only every 8 to 10 days and lose up to 30 % of its body weight through dehydration. This remarkable attribute results from a very low basal metabolism and exceptional water-conserving adaptations. The camels are exposed permanently to the heat of the desert sun without shelter possibilities. They cannot escape the heat in burrows or under trees.

In hot dry areas such as the Empty Quarter of Arabia, the Sahara in Africa or the Death Valley in America, the water loss through sweating (evaporation) is enormous and may exceed one liter per hour. In these hostile environments, a human will be close to death after one day without drinking. For animals, the question is how to secure water, because they are unable to stockpile it. The camel is no exception. It does not store water in its body, either in the stomach or in the hump.

Through evolution the 'ship of the desert' has developed several mechanisms for restricting water loss when intake is reduced, making life in a very harsh climate possible. The combination of these mechanisms is without parallel in any other domesticated animal.

Fig. 7: A camel, in a heavily overgrazed desert in the western part of Qatar.

Photo: Marc Breulmann

A very important physiological aspect of the ability of camels to conserve water is their production of small, hard and very dry droppings. Cattle lose 20 to 40 liters of fluid daily through faeces, whereas camels lose only 1.3 liters. This is one of the primary methods for resisting water deprivation in the desert. Fluid is absorbed in the end part of the intestines, where the small faecal balls are produced. Water is lost from the body by evaporative cooling, in the faeces and in the urine. The camel is able to achieve considerable savings of water from these sources. The function and structure of the kidneys are also of major importance in water conservation. The long loops of Henle, which are four to six times longer than in cattle, have the function of both, concentrating urine and reducing its flow. A dehydrated camel urinates only drops of concentrated urine being shown by white stripes of salt crystals on the hind legs and tail. This concentrated urine not only serves to conserve water, but also allows camels to drink water which is more concentrated than sea water (above 3% NaCl), and to eat salty plants (halophytes) that would otherwise be toxic.

Dehydrated camels save water by increasing their body temperature to over 42 °C, thus saving water that would otherwise be secreted as sweat to cool the body. The body temperature is adapted to the outside temperature. The high blood temperature however would damage the most heat sensitive cells, which are those of the brain and retina, if the high body temperature continues for several days or even weeks. In this situation the camel switches to an even more remarkable mechanism, which has been described as an 'inbuilt air-conditioning system'. When a dehydrated camel inhales, air flows over its large nasal surfaces, drying them out and consequently forming a layer of dried-out mucous and cellular debris on the nasal surfaces. These dried-out secretions are hygroscopic and therefore, take up water from the exhaled moist air coming from the lungs. Water is extracted from the exhaled air and therefore the camel's breath is dry. The large camel nasal surface absorbs the vapor and cools a network of small blood vessels, named the 'carotid rate'. This carotid vessel network surrounds the jugular vein and cools its blood. On the way to the heart the cooled venous blood meets the warm arterial blood going to the brain and eyes, cooling it by more than 4 °C. This is called a 'counter current' effect. This life saving mechanism was first discovered and studied two decades ago by the Norwegian physiologist Kurt Schmidt-Nielsen who published his discoveries both in scientific journals and in his autobiography 'The camel's nose' (SCHMIDT-NIELSEN 1998).

Fig. 8: Cows, which have died from plastic ingestion.

Photo: Ulrich Wernery

2.3 Fatal Pollution

One day the "Empty Quarter" will be called "Full Quarter". Picnickers, campers, wadi-bashers, off- roaders and endurance riders leave their bags, bottles, caps, lids, plates, containers, cutlery, ropes, loops of can holders and even tyres in the desert. It is difficult to clear away the trash, which does not stay just where it is thrown. It blows away with the wind, reaching the most remote desert areas; clinging on trees and shrubs and is covered by a veneer of sand, polluting the most picturesque places of the desert. It is not just an eyesore. Plastics and rubbish represents a considerable danger to wildlife and livestock.

Fig. 9: Five camel calves feeding on plastic bags carelessly dumped into the desert.

Photo: Ulrich Wernery

Fig. 10: A camel has succumbed to rubbish ingestion.

Photo: Ulrich Wernery

In general, every year hundreds of animals face agonizing deaths by ingestion of plastic in the deserts, the seas and even in the cities. Animals are curious and especially young animals sniff at trash, nibble at it and then swallow it and die a slow and painful death. Some may survive longer until their intestines are blocked or noxious ingredients are released into the organism. Over the last decade many animals which were necropsied at the Central Veterinary Research Laboratory (CVRL) in Dubai, died from trash ingestion; including camels, cattle, sheep, goats, gazelles, ostriches and houbara bustards.

This kind of pollution has reached "epidemic" proportions and the pictures (**Fig.** 8-12) *speak for themselves.*

Fig. 11: Only bones and a huge plastic conglomerate where the stomach was, is left behind.

Photo: Ulrich Wernery

Fig. 12: A cow with a huge mass of plastic in its rumen.

Photo: Ulrich Wernery

3. The "Camel Farm" and its Products

The dromedary camel possesses a high productive potential. It is a multi-purpose animal and unlike any other domesticated animal, has been utilized by humans for centuries for transport, traction power, milk, meat, wool, skin and even fuel. In the countries of East and North Africa, as well as in some Asian countries, camel milk is still the main food source for the nomadic people, as it was for the Bedouins of Arabia before the oil boom. Dromedaries are also resistant to several cattle diseases, like Foot-and-mouth, Rinderpest and Bovine Pleuropneumonia.

The camel is universally highly valued and constitutes a social standing for its owner. To date, the productive potential has been neglected by governments and scientists. The camel is an alien animal to Western societies and is loaded with negative prejudices and misconceptions. However in time of global warming, growing deserts and increasing scarcity of water and food, camels would be an alternative sustainable solution to these problems.

Nowadays, even some Masais and Samburus, who are real cattle breeders, have given up cattle rearing in Kenya and Tanzania for camels. In desert areas camels are far better suited than cattle and small ruminants for animal husbandry. Unlike sheep and especially, goats, which clear every piece of vegetation to the roots and denude areas, camels take only a few bites from a shrub or a tree and then move on.

3.1 The Farm

3.1.1 *Experimental Research Studies*

The recovery and restoration of these rangelands is essential for its sustainable management and animal production and the conservation of biodiversity. Camel Farms can be used for milk and meat production and allow for rangeland and ecosystem recovery. Experimental plots must be established to study the succession of plant species of the ecosystem, the "rate of recovery" and to investigate and demonstrate the advantages of the Camel Farm.

The experimental grazing plots will be divided into the following five divisions:

Plot 1: Without camel grazing and fully protected from human disturbance.
Plot 2: Grazing is allowed but below the ecological carrying capacity.
Plot 3: Overgrazing (no change of current management).
Plot 4: and **Plot 5**, Rotational grazing, according to the traditional "*hema*" system is introduced in order to regenerate the rangeland. Animals are kept off the rangelands when the important palatable species are flowering and until there has been sufficient rainfall. There are two types of "*hema*"system; temporary and permanent. In one grazing plot the grazing stops for one or several seasons. This system is cited in the Holy Quran, was supported by the Shari' ah (Islamic law), the Hadith (sayings of the Prophet) and Sunnah (traditions of the Prophet). The "*hema*" system was possibly developed as a way of conserving and protecting natural resources of pastures, representing the earliest known record of rotational range management in history.

(Chaudhary & Le Houérou 2006)

A small research center for fodder nutrient analysis and for quality control of milk should be available for scientists. The scientists could carry out research on the camels to ascertain whether they can be fed with indigenous or salt tolerant plants and still produce the same quantity and quality of camel milk. The laboratory should also be used to investigate the minimum quantity of water needed to produce one liter of camel milk and to study the effects of different desert plants and halophytes on the taste and quality of milk and meat. The water use efficiency (WUE) of the plant species, used as camel fodder, and the effects of different fodder consumption rates are also important aspects which should be studied.

Fig. 13: Fodder production farm which focuses on exotic species (United Arab Emirates; see also **Fig.:** 6).

Photo: Marc Breulmann

Fig. 14: Modern milking machinery in a Camel Farm in Dubai, United Arab Emirates.

Photo: Ulrich Wernery

To protect and rehabilitate the desert environment according to its natural conditions, the grazing site at the Camel Farm has to be carefully researched (rangeland vegetation ecology). The following criteria have to be taken into account, each with its own policy and ecological consideration (Gallacher & Hill 2006 b):

- The carrying capacity of camels must be studied, and numbers of camels/ha has to be adapted accordingly.
- A limited number of animals shall still be allowed to graze in the desert because camels are important pollinators as well as seeders in the desert ecosystems.
- The grazing area must be protected from human interference and excessive camel grazing by a fence and an ongoing daily patrol.
- The camels stay in a fenced area where they are fed on indigenous plants, where they are given access to water and where camel products are produced.
- Specific fodder should be produced adjacent to the farm, such as indigenous desert plants and halophytes.

(Gallacher & Hill 2006 b; Ksiksi *et al.* 2006)

3.1.2 *Renewable Energy*

The entire Camel Farm can be built in an environmentally friendly way. The farm should be established in an arid region where solar radiation levels are generally high. It should use solar cells to generate electricity directly from sunlight or wind power to be used for the entire farm. The farm could demonstrate the advantages of solar electricity to the particular region. Building a Biogas-plant should also be considered as an alternative method for the production of electricity. Camel dung can also be used as fertilizer for fodder production.

3.2 Camel Products

3.2.1 *Camel Milk*

It has been shown that camels can be managed in closed farms like cows. On these farms they would primarily produce milk and meat. In Dubai, United Arab Emirates, one such camel farm already exists where, in 2007, some 600 camels produce about 6000 liters of milk per day (~10 liters milk/day/camel), which is commercially sold in the city of Dubai ("Camelicious"). The Food and Agriculture Organization (FAO) estimates that the global market in camel milk potentially is worth over 10 billion USD. In Dubai, specialized camel milking machinery was developed, which makes the Camel Farm a modern and practical dairy farm. With improved feed, water availability, husbandry and veterinary care, daily yields could rise to 20 liters milk per day/per dromedary.

Fig. 15: Upper view of a modern milking machinery for camels in Dubai, United Arab Emirates.

Photo: Ulrich Wernery

Fig. 16: Camel advertisement for "Camelicious", the brand in the United Arab Emirates for camel milk.

Photo: Ulrich Wernery

Camels can produce four times more milk in the desert environment than domestic cattle. Cattle are highly efficient in milk production in temperate climates or when their environment is air-conditioned or where water sprinkling systems are used for cooling the animals to keep their body temperature at 37 ºC. This of course uses an enormous amount of energy and water, causes hygienic problems and is not environmentally sustainable.

In cows, if this is not done, the reservoir for milk-water is lost for body cooling which leads to cessation of lactation or to a very concentrated high fat and low water content in the milk. In contrast, camels can be easily managed in open pens with little shade and need to be neither cooled down nor watered daily. In drought-stricken areas of the world, where continuous drought decimates cattle, sheep and goat populations, only the camel survives and continues to produce milk. In arid and semi-arid zones where camels are reared, the milk yield of camels is four times higher than that of indigenous zebu cattle. Daily milk yields have been reported to be between 3 to 40 liters.

One of the remarkable features of dehydrated camels is their ability to continue lactation and to secret milk that is highly diluted with over 90% water content. A 600kg camel for example, has about 200 liters of fluid in the alimentary tract, which is available for milk production, giving 20 liters per day for 10 days (Yagil 2000).

Lactating camels, therefore, will guarantee ample food with the desired content for their offspring and humans alike. Camel milk is a rich source of proteins with potential anti-mi-

crobial and protective activity. Some proteins are not found in cow milk. Components of camel milk differ considerable from those of ruminants (cow, sheep and goat).
The high concentration of niacin and vitamin C, the high water content, especially during the hot summer months, and the low fat content of camel milk are remarkable. Furthermore, the fat of camel milk does not form a layer when kept undisturbed, and it is evenly distributed throughout the milk in small micells.

Camel fat also contains higher concentrations of long-chained fatty acids (C_{14}-C_{18}) than short-chained fatty acids, and is therefore healthier. Camel milk does not coagulate easily. It passes the acid stomach unchanged and reaches the intestines for absorption. Because the milk does not curdle, either with acid or with rennet, cheese, especially hard cheese, is difficult to produce. The reason for this is still poorly understood.

Milk allergy and lactose intolerance, which are very common in the western world, are unknown diseases with camel milk. Milk allergy occurs globally in 1% to 7% of all infants, and it is believed that the absence of betalactoglobulin and the different composition of beta-casein in camel milk prevent allergic reactions. Therefore, camel milk would be an interesting alternative for infant milk products. Lactose intolerance is a different entity. It occurs in people above 5 years as a result of the decrease or absence of an enzyme called lactase in the gastrointestinal tract. Approximately 90%-95% of black individuals and only 20%-25% of white individuals throughout the world have partial or complete lactose intolerance. Although the lactose content in camel milk is as high as in cow milk, camel milk lactose intolerance does not occur. The reason is also not yet known (Wernery & Wernery 2006).
The proposed Camel Farm would not only produce camel milk for commercial purposes but also other milk products, including yoghurt, cheese and laban.

Fig. 17: Truck for transportation of camel milk "Camelicious" (United Arab Emirates).
Photo: Ulrich Wernery

Camel milk is healthy and has the following advantages in comparison to cow milk:

- It can be produced in a non air-conditioned environment.
- It has five times higher Vitamin C content.
- Rich in iron.
- Contains 50 % less fat.
- Reduces cholesterol.
- Is compatible among people who are lactose intolerant.

3.2.2 *Camel Meat*

The increasing human population of the desert regions, which in the past consumed meat only occasionally is more demanding today.

To put in contrast, the meat produced in arid regions is very small in comparison to the need of the vastly increased affluent population. It is difficult for countries in arid regions to be self-sufficient in meat production. The proposed Camel Farm has to be managed in a way so that there is a sustainable production of meat and other products (Finke 2005).

It is known that camel meat contains very little fat and cholesterol. Surplus male camels, which are not needed for reproduction or racing, can be reared and slaughtered in a special abattoir adjacent to the Camel Farm, when they are approximately one year old.

3.2.3 *Breeding*

Modern camel dairies will not only guarantee higher milk production and milk hygiene but would also improve the social status of camel farmers.

Beside the camel products, an important aspect of camel farming is the breeding itself (Farah *et al.* 2004). At this moment no big scale camel dairies exist. If in the future camel milk is produced commercially, camels with a uniform udder and high milk yield must be bred. With artificial insemination and embryo transfer, which has gained major momentum in camel racing, could improve milk production in the near future.

Breeding special camels for milk production locally (to increase the yields of milk) and/or breeding racing camels would be just two attractive alternatives.

3.2.4 *Camel Racing*

Camel racing is a major traditional heritage sport in the Arabian Gulf region. Good race camels can fetch high prices (Khalaf 1999).

Camel racing is a growing traditional heritage sport in modern-day Gulf Arab societies. In the past, the Bedouins organized camel races just on festive social occasions such as weddings, religious feasts or celebrating rainfall. Today camel races have developed into a mass media event. During the racing season from October to April the camel races become the center of attention for locals, foreigners and tourists. Television brings this sport to everybody's home.

This growing industry brings not only cultural satisfaction and social honor to the people but also large material benefits to people directly involved in camel races, such as trainers and owners.

3.2.5 *Tourism*

A Camel Farm could also be used as a tourist attraction. Tourists could enjoy day trips to the desert or the coast by riding camels (Camel safaris), enjoying the desert and possibly a sunset barbeque or spending a night in the desert before returning. This is an eco-friendly method to provide a link to nature.

Rangelands can recover fast and provide habitat structure for endangered wildlife, such as oryx, gazelles, desert hare and houbara bustard. Wildlife can be re-introduced and wildlife safaris and sustainable hunting may be of interest for tourism.

Camel skin has no major commercial use for leather production. But it may have a value for tourists. Camel hides are very strong with a tensile strength, five times greater than cattle hides. Camel leather is being crafted for fashion garments such as leather wallets, handbags, purses and shoes.

Since these products in general are made from goat leather, camel leather products should be branded as such. Tourists could purchase handmade camel leather products such as fashion accessories and souvenirs directly from the farm.

Fig. 18: *Acacia tortilis*, an indigenous desert plant, which can be used as camel fodder (Qatar). **Photo:** Nicholas Pilcher

3.3 Proposed Fodder Production and Water Savings

In the model Camel Farm fodder production should be of two forms:

- Indigenous desert plants.
- Salt tolerant plants.

Nowadays in the Arabian Peninsula most groundwater is saline and freshwater is very limited. The water consumption for fodder production can be minimized by using desert plants. Also saline water and even salt water can be used to grow salt tolerant plants as camel fodder.

At the beginning of the 20 th century only a few cities with small populations existed. Total water use was limited. Therefore there was no concept of the modern sanitary systems. The wastewater treatment plants provide tertiary treated water in abundance, in amounts unimaginable in the past. This large amount of wastewater can also be used most profitably to grow livestock fodder including large plantations. Various irrigation technologies such as sub irrigating deep sands with treated or untreated sewage water could be adopted to do this.

3.3.1 *Indigenous Desert Plants*

By feeding camels on native desert plants or hay (*Cenchrus ciliaris, Pennisetum divisum, Panicum turgidum, Rhanterium epapposum* for example), instead of alfalfa and rhodes grass, valuable freshwater could be saved as these species have a better WUE (Water Use Efficiency) (Peacock *et al.* 2003 a; Böer 2006).

Similarly, fresh water could also be saved by growing *Sporobolus* spp. (*Sporobolus iocladus* and *Sporbolus spicatus*) and other salt tolerant palatable species.

Fig. 19: *Zygophyllum qatarense*, a camel grazing plant, adapted to the hot and dry desert conditions of Qatar.
Photo: Nicholas Pilcher

3.3.2 *Salt Tolerant Plants*

The so-called biosaline farms could be established, for example in a sabkha (DE SOYZA *et al.* 2002) and next to the shore, to increase the fodder supply in the Camel Farms. Halophytes can be used as camel fodder. Camels need a daily intake of 20g salt per 100kg body weight.

These biosaline farms are based on utilization of saline water for saline and salt-water tolerant plants. The salt tolerant plants, called halophytes, represent a wide range of different plant species including grasses, shrubs and trees. They can be irrigated with brackish water and some even with seawater, minimizing the need for freshwater. Until now only a few different plant species have been evaluated for their economic potential as livestock fodder (CHOUKR-ALLAH 1996; PEACOCK *et al.* 2003 a; ÖTZTÜRK *et al.* 2006).

The UNESCO Office in Doha has already developed two project proposals of establishing a biosaline agriculture pilot farm for livestock production in the coastal zone of Sudan (BABA *et al.* 2003; LOUGHLAND *et al.* 2004). The highly productive systems of Sea grass and Mangrove systems also have potential for camel fodder cultivation using highly saline water.

3.3.3 *Feeding Camels on Halophytes Under Arid Conditions: New approaches for enhancing utilization and economic feasibility*

The arid regions are classified as the poorest in the world in the availability of renewable fresh water resources. The Middle East and North Africa region (MENA) have reached the absolute water scarcity level where the available water per capita is less than 1000 m^3/year. It means that they do not have sufficient water resources to meet reasonable water needs for domestic, agriculture and industrial purposes. Animal production constitutes the main sources of income of the region's population. Animal production systems in these countries are depending to a large extent on natural vegetation (GIHAD & EL SHAER 1994). However, rangeland vegetation throughout the MENA is often severely reduced in productivity and diversity.

Fig. 20: Mangroves also have potential for camel fodder cultivation (Qatar).
Photo: Benno Böer

Fig. 21: Goats, on their way back to a farm. The desert is heavily overgrazed, barely any vegetation is left. (Qatar).

Photo: Marc Breulmann

Halophytes are a long neglected resource in arid and semi arid regions. They are promising and have the potential of being superior animal feed resources (Gihad & El Shaer 1994). Feeding halophytes particularly to camels is a feasible solution to minimize the problem of feed shortage. Camels as well as other livestock have adapted microorganisms in their rumen, which can make use of the non-protein nitrogen in halophytes.

Halophytes include several fodder, salt tolerant grasses and legumes of high productivity and suitable nutritive value (El Shaer 1995). Some halophytes, whether cultivated or naturally grown, could be fed to all livestock species as good quality fodder (El Shaer 1996). Just a few halophytic species such as *Atriplex halimus*, *Tamarix aphylla*, *Tamarix mannifera*, *Halocnemum strobilaceum* and *Zygophyllum album* appear to be less or unpalatable due to their higher anti-nutritional factors such as tannins, alkaloids, and saponins (Kandil & El Shaer 1990, El Shaer1996).

Most halophytes contain various concentrations of different secondary plant metabolites, so called anti-nutritional factors, which have significant impact on their utilization as fodder. These anti-nutritional factors form insoluble complexes with essential minerals, proteins and carbohydrates, lowering the nutritive value of products. However only further studies can show the extend of palatable halophytes.

It is of interest to decrease the impact of desertification as well as to provide available high-quality fodder resources to minimize the production costs of fodder. Restoration of rangelands with palatable salt tolerant and drought resistance forage crops is a suitable approach for combating soil degradation and rangeland deterioration. Therefore the natural vegetation has to be protected from overgrazing to reduce the desertification process in the region and allow for palatable species to return.

The utilization of range plants alone as sole diets, fed individually or mixed with other feed ingredients have been broadly investigated (Kandil & El Shaer 1990, El Shaer 1996, El Shaer & Ismail 2002). It is concluded from these studies that feeding sheep and

Fig. 22: *Sporobolus iocladus,* a palatable indigenous desert grass for livestock.

Photo: Nicholas Pilcher

goats on halophytes provide fodder of high-quality all the year around.

The fodder production costs will decrease up to 35% while also large amounts of fresh water can be saved.

Unfortunately there is limited information available, concerning the effects of feeding halophytic plants on camel performance and productivity. Therefore it is important to conduct experimental studies for better utilization of saline soils and saline water, to decrease the desertification process and for providing secured and sufficient food for humans in arid and semi- arid regions.

Fodder and feeding studies should focus on two main objectives:

1. Determination of different camel type diets in four forms: fresh, treated hay, silage and feed blocks based on halophytes.

2. Elaborate halophytes with a high nutritional values.

Fig. 23: Striking growth of *Pennisetum divisum* after just six weeks growth in the field at the Kuwait Institute for Scientific Research, Aridland, Agriculture & Greenery Department.

Photo: Gary Brown

Fig. 24

Fig. 25

The pictures (**Fig.** 24-26) are taken in Qatar and show two farms for fodder production (**Fig.** 24 and 25). The farms are located in the north west of Qatar, in the middle of a heavily overgrazed gravel desert. The fodder plants need a large amount of fresh groundwater which is pumped up to the surface from deep fossil water reservoirs (**Fig . 26**). These farms could be modified in order to produce desert or/and salt tolerant plants as camel fodder, which then can be delivered to the camel farms.

Photo: Marc Breulmann

Fig. 26

3.3.4 *Waste Water use for Fodder Production*

Another important aspect is the irrigation with waste water. A mixture of selected native plants and halophytes, forming three or four layers of species, can be used, for this type of fodder production plant. The layers could consist of the following plant species:

1. **1st layer:** *Acacia nilotica*, *Acacia tortilis*, mixed with *Maerua crassifolia, Salvadora persica, Acacia gerrardii, Pithecelobium dulce* and *Tamarix species* like *Tamarix aphylla, Tamarix nilotica.*
2. **2nd layer:** *Acacia ehrenbergiana*, *Calligonum arabicum*, *Calligonum comosum*, *Haloxylon* species like *Haloxylon persicum*, *Seidlitzia rosmarinus*, *Reaumuria* spp *Salvadora persica*, *Leptadenia pyrotechnica*, *Suaeda monoica* and *Suaeda fruticosa* including some tall *Atriplex* species and *Avicenna marina*.
3. **3rd layer:** tall grasses like *Panicum turgidum*, *Pennisetum divisum*, *Lasiurus scindicus*, shrubs like *Atriplex halimus*, *Atriplex canescens*, *Atriplex nummularia*, *Cornulaca arabica*, *Haloxylon salicornicum*, *Rhanterium epapposum*.
4. **4th layer:** salt tolerant or other hardy well known high yielding species like *Salsola villosa*, *Salsola spinescens*, *Salsola cyclophylla*, *Salsola tetrandra*, *Traganum nudatum*, *Halothamnus iraqensis*, *Halocharis sulphurea*, *Zygophyllum* spp., *Cyperus eremicus*, *Cyperus macrorrhizus*, *Cyperus conglomeratus*; low perennial and annual *Atriplex* species like *Atriplex suberecta*, *Atriplex rhagodioides*, *Atriplex glauca*, *Atriplex lentiformis*, *Atriplex leucoclada*, etc.

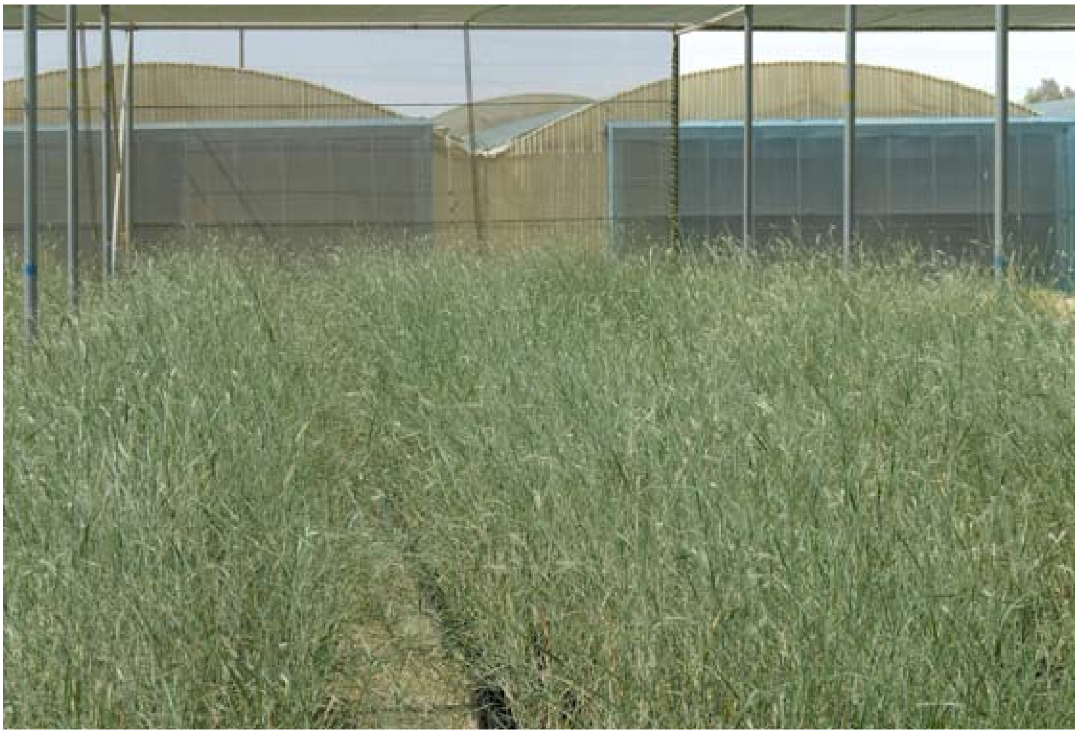

Fig. 27: *Pennisetum divisum* in a shade house in one gallon pots Kuwait Institute for Scientific Research, Aridland, Agriculture & Greenery Department, to be used for habitat restoration.

Photo: Gary Brown

Fig. 28 shows the recovery after two years of the desert vegetation in a fenced area, protected from grazing and human interference, in Qatar.

Photo: Marc Breulmann.

Fig. 29: Picture above: field prepared with three month old *Panicum* plants. Picture below: same area after six weeks. The grasses are grown on the farm for seed production and to cut the grass to use as fodder (different cutting regimes are used). *Pennisetum* (see also **Fig**. 23 and 27 need little water to keep them green throughout the summer. The plants need about six gallon of fresh water a week/plant with drip irrigation systems. They are irrigated twice a week for 30 min. each time. The studies are carried out at the Kuwait Institute for Scientific Research, Aridland, Agriculture & Greenery Department.

Photo: Gary Brown

4 Outcome

Many investigations have shown that desert ecosystems recover in a very short period of time when free-roaming livestock-are kept in low numbers or are completely removed.
Experiments on enclosures in Abu Dhabi and Kuwait have demonstrated, that even after one year with average rainfall a visible recovery takes place, which becomes even more obvious after two years (Böer & Norton 1996; Barth 1999, Peacock *et al.* 2005). The productivity in enclosures is two to four times higher than in grazed rangeland (Chaudhary & Le Houérou 2006). Desert ecosystems have the ability to recover after grazing conditions have improved (Gallacher 2007).

After the Gulf War, many areas of Kuwait for example, were inaccessible due to landmines. Within two to three years, these areas recovered and wildlife and flora came back.

The proposed Camel Farm should lead to significant benefits. Desert landscapes become more attractive once the fauna and flora densities increase, and wildlife numbers recover. Habitats for small animals like lizards, nesting birds and insects are restored and indigenous animals like oryx, gazelles, desert hares and the houbara bustard could be released into the wild. Visitors could be taken on tours through the recovered enclosures to observe the wildlife.

Another possibility is the establishment of a Camel Farm in a Biosphere Reserve or Natural Heritage Site. Once the desert has recovered to its natural state, the traditional way of desert living could be presented to the public. Sustainable hunting could be introduced to attract tourists. Reserves based on tourism would provide salaries for site managers. Also the traditional falcon or salouki hunting might again become a popular event in particular restored region for locals and tourists.

The protected areas can demonstrate to school children for instance, the natural desert landscape if grazing is controlled, demonstarte how to protect the desert environment. Educational facilities and the involvement of local as well as international universities in the research studies will be encouraged.

Fig. 30: Grazing sheep flock in the northeast of Qatar.

Photo: Nicholas Pilcher

5 Project Development

The UNESCO Office in Doha intends to support the development of a well organized Master Plan to initiate the construction of a prototype Camel Farm.

This Camel Farm uses experimental plots to demonstrate, as mentioned in this proposal, the following aspects:

1. Combating desertification to restore desert ecosystems
2. Viable production of commercial farm products
3. Reduction of water usage for fodder production

Developing the Master Plan will take approximately 24 Months.

The development of the Master Plan can be divided into the following steps:

1. UNESCO Doha Office, in collaboration with a team of experts of different scientific disciplines finalize the project proposal. This includes the following:

   a. Develop a vision and strategic plan.
   b. Develop a Master Plan.
   c. Recruit a project manager, who will be responsible to coordinate the development of the Master Plan as well as all related issues.

2. Inform potential donors and institutions about the project by presenting materials and publications, develop relations and contacts with possible donors, companies and finally promote fund raising campaigns.

3. It is recommended that UNESCO, with experts, companies, stakeholders, international organizations, representatives and Member States, embark on a Workshop to discuss the objectives of the Master Plan as well as a possible

Fig. 31: A small camel herd, grazing with two oryx in a forest in the United Arab Emirates.
Photo: David Gallacher

Fig. 32: A camel grazing on dry shrubs in the United Arab Emirates.

Photo: David Gallacher

location for the farm. The workshop should include the local stakeholders and experts of the field: Desertification, overgrazing, restoration and rehabilitation of rangelands, botany, architecture, rangeland and livestock management, sustainable energy use.

The following aspects shall be decided:

- Identify suitable sites.
- Conduct a survey (inventory control) of the site (including vegetation, fauna, climate and soil analyses).
- Develop a list of species of desert plants and salt tolerant plants to be grown in the farm (consideration of their adaptability, productivity and palatability).
- Decide what kind of studies and research are required, concerning: restoration methods, fodder production (in order to secure the needed optimal nutrition for the livestock), milk and meat production and management.
- Decide on methods of husbandry and fodder production.

4. Data of scientific research studies that have been carried out in the past will be collected and analysed, in order to obtain all information needed for the proper design of the farm and optimal management and guidelines and the results of the study will be published.

5. Modify the final version in light of outputs from the Workshop in order to fine tune the final Master Plan.
6. Presentation of the final version and complete Master Plan of the Camel Farm.

5.1 Budget

Development of Budget Breakdown	Cost Headings
Proposal Setup	costs covered by UNESCO and DAAD
Project Manager	90.000 USD
Fund raising : Travel costs; Presentations	no costs
Workshop 1	105.000 USD
Guidelines for Master Plan	45.000 USD
Productions and Presentation of a Master Plan (Contract for three expert consultants)	260.000 USD
Sub-total	500.000 USD
Administrative support (13 %)	65.000 USD
Total	565.000 USD

6 Benefits in Short

In conclusion the Camel Farm will contribute combating desertification, assist with the recovery of desert ecosystems and reduce fresh water consumption in the area.

In the long term, complete industries could be established linked to Camel Farms. These farms will provide innovative alternative sources of income.
The Camel Farm can be built near bigger villages or cities to ensure safe transport of products to local markets. Jobs could be generated, not only at the farms, but also linked to tourism, education and in transport sectors.

The Camel Farm will provide a sustainable economy for those involved in the project. Also Camel Farms can indirectly contribute to desert ecosystems' restoration. The diets and the feeding behavior of camels will be markedly improved. Providing large amounts of hay of various indigenous grasses may also improve the taste of the milk and meat.
However, significant studies are needed to understand the effects of different desert plants and halophytes on milk yield and taste, as well as on the general health and requirements of milking camels.
This new sustainable livestock industry needs to be developed simultaneously with strict grazing laws and regimes set up by the government to protect the desert environments in the Arabian Peninsula from overgrazing and general misuse.

Significantly more studies are needed, particularly to understand the linkages between combating desertification and the establishment of a Camel Farms. These farming options present a novel approach to sustainable use of natural resources. The farms are also linked to traditions and culture of the people living in the arid regions.

Once the advantages of the established Model Camel Farm are visible and the research studies, carried out in the farm, are publicized, the Camel Farm can be replicated in Qatar, in other countries in the Arabian Peninsula and elsewhere with similar ecological conditions and problems.

Fig. 33: Two camels grazing next to the road in northern Qatar.

Photo: Marc Breulmann

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Fig. 34: Herd of goats, grazing on a tree Qatar).

Photo: Nicholas Pilcher

ملخص البحث

لقد أعطت منظمة الأمم المتحدة للتربية والعلوم والثقافة (UNESCO) اهتمام للتهديدات المستمرة للتصحر التي تواجه دول العالم بالإضافة إلى تأثير التصحر في تعرية التربة، كما أن للتصحر تأثيرات هائلة على مجمل النظام البيئي. ففي عام 2006 والذي خصص ليكون العام الدولي للصحارى والتصحر زاد من وعي وأدراك جميع المهتمين على ضرورة توفير جميع الإمكانات والأموال المتاحة للتركيز على التنمية المستدامة. إن تحسين المعرفة لأسباب التصحر وتطوير التنمية المستدامة ضرورية لإنعاش النظام البيئي، وعليه يجب إيجاد الحلول المناسبة لوقف تعرية التربة وتطوير خطوات في إدارة المحافظة والاستدامة لمصادر الأراضي والمياه.
أثبتت العديد من البحوث والدراسات العلمية إن الرعي الجائر للإبل إلى حد يفوق الحمولة الرعوية المسموح بها هو من أهم المعوقات التي تودي إلى تدهور النظام البيئي الصحراوي، فبخفض أعداد الإبل التي يسمح لها بالرعي إلى الحد الأدنى من الحمولة الرعوية المحددة يمكننا من استعادة الغطاء النباتي والمحافظة عليه من الرعي الجائر مما يؤدي إلى وقف التصحر.
ويعتبر التنوع البيولوجي والإنتاج الحيواني في مراعي الجزيرة العربية حساس للغاية. حيث إن أي زيادة في أعداد الأغنام والماعز والإبل سوف يؤدي إلى تدهور المراعي والتي تحتوي على أكثر من 3500 نوع من النباتات وخاصة النباتات ذات الاستساغة العالية. وحاليا فإن أكثر من 90 % من المراعى تعاني بدرجات متفاوتة من الرعي الجائر، ومنها حوالي 40 % تعاني تم تدميرها بسبب الرعي الجائر. وقد وجد كثير من الباحثين أن كثافة الإبل التي تزيد عن الحمولة الرعوية تعتبر عامل أساسي يهدد البيئة الصحراوية.
إن خفض أعداد الإبل في المراعي سوف يؤدى إلى منع التصحر وذلك لإعطاء الفرصة للنباتات للنمو والتكاثر. وإن إنشاء مزارع للإبل سوف يعمل على تشجيع ملاك الإبل إلى التحول من نظام الرعي (الإنتاج المكثف) إلى نظام التربية في حظائر (الإنتاج المركز) حيث يتم تغذية الإبل بنباتات صحراوية محلية أو نباتات مقاومة للملوحة والتي سوف يتم إنتاجها في المناطق المجاورة لهذه الحظائر مما سيؤدي في النهاية إلى الحفاظ على النباتات وتحسين البيئات الصحراوية

كما يمكن إنتاج الأعلاف من النباتات الصحراوية المحلية في مزارع إنتاج أعلاف تجارية مما يعمل على استدامة إنتاج الأعلاف من خلال خفض كميات المياه المستخدمة في إنتاج الأعلاف. كما يمكن إنتاج أعلاف متحملة للملوحة كأعلاف للإبل. إن الأعلاف المروية التي تم إدخالها للمنطقة مثل حشيشة الرودس والبرسيم (القت) يتم زراعتها حاليا لإنتاج أعلاف لتعويض نقص أعلاف المراعي. هذه الأنواع من الأعلاف تستهلك كميات هائلة من المياه ما يعادل 48000 متر مكعب للهكتار للعام الواحد وهو غير قابل للاستدامة ولهذا فأن منسوب المياه انخفض بشكل كبير وفي كثير من الحالات أدى إلى ارتفاع نسبة الملوحة في مياه الآبار. وتعتبر الحشائش الرعوية المحلية متأقلمة للظروف البيئية المحلية ويعرف عنها استجابتها لكميات قليلة من مياه الري. وهناك حاجة ماسة وملحة لجمع وحفظ هذه الحشائش والعمل على تقييم إمكانية استخدامها كأعلاف مروية باستخدام أقل كمية ممكنة من المياه العذبة أو استخدام المياه المالحة.
إن إعادة تأهيل المراعي الصحراوية وإعادتها إلى ما كانت عليه في السابق يمكن توضيحه وتأكيده بدراسات يتم أجراؤها في المزارع والمراعى المفتوحة. ومن مخرجات دراسات هذه الأبحاث إيجاد بيئات صحراوية مستقرة وتحسين البيئات الصحراوية.

أهم ثلاثة نتائج متوقع الحصول عليها من هذه الدراسات:

1. **وقف التصحر وإعادة تأهيل البيئات الصحراوية**
2. **الحصول على منتجات حيوانية تجارية وخاصة حليب الإبل والذي يعتبر ذو قيمة غذائية عالية.**
3. **خفض كميات المياه المستخدمة لإنتاج الأعلاف**

سيتم في هذا المقترح تفسير تأثير التصحر والرعي الجائر على البيئة الصحراوية كما سوف يتم وضع المقترحات المناسبة (مزارع الإبل) لإعادة تأهيل هذه البيئات إلى ما كانت عليه في السابق، بالإضافة إلى توضيح القيمة التجارية لمنتجات مزارع الإبل وتوفير مياه الري لإنتاج أعلاف للإبل باستخدام النباتات المحلية والنباتات المقاومة للملوحة عند زراعتها كأعلاف مروية باستخدام كميات قليلة من المياه.

Oryx with its calve in Qatar.
Photo: Henning Schwarze

Protected desert area in Qatar.
Photo: Marc Breulmann

Zygophyllum qatarense (Qatar).
Photo: Nicholas Pilcher

Mangroves in Khor Kalba (UAE).

Photo: Benno Böer

Modern Camel Farm (UAE).

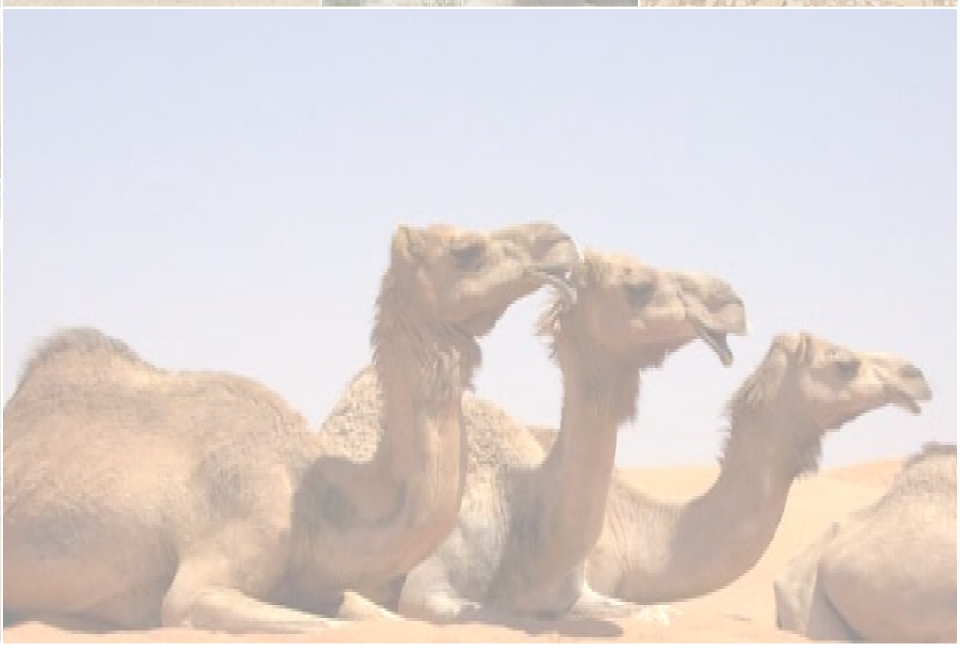
Photo: Ulrich Wernery

Growth of *Pennisetum divisum* after seeks weeks.

Photo: Gary Brown

Dried soil.

Photo: Nicholas Pilcher



A group of camels enjoying the sun; **Photo:** David Gallacher

مكتب الدوحة

منظمة الأمم المتحدة
للتربية والعلم والثقافة

الإبل

من التقاليد إلى الحداثة








مشروع بحث مقترح من أجل مكافحة التصحر من خلال إنشاء مزارع للإبل تعتمد على إنتاج أعلاف من نباتات رعوية محلية متحملة للجفاف أو الملوحة

مكتب الدوحة

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جون نورتن ،غاري براون ،شوكت علي شودري ،جون بي كوك