

**GOATS: AN ALTERNATIVE MEAT SOURCE AND A MEANS TO STOP
DESERTIFICATION**

**A SENIOR RESEARCH PAPER PRESENTED TO THE FACULTY OF THE
BIOLOGY DEPARTMENT OF DRURY UNIVERSITY**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
BACHELOR OF SCIENCE**

**BY
CLINTON L. SEVERE**

I AM AN UNDERGRADUATE STUDENT – SPRING 2013

ACKNOWLEDGEMENTS

I would like to thank the two local veterinarians - Bryan Buttress, DVM, and Steven E. Root, DVM. They referred me to the Merck Veterinary Manual, University of California – Davis, and Oklahoma State University sources. I would also like to thank my instructor Tim Casey for his patience and help with this paper.

TABLE OF CONTENTS

INTRODUCTION.....	5
METHODS AND MATERIALS.....	6
RESULTS AND DISCUSSION.....	7
CONCLUSION.....	40
LITERATURE CITED.....	41

ABSTRACT

Goat (*Capra hircus*) products are compared with other livestock products, to assess the respective health benefits to human consumers. The causes and effects of desertification are presented in context of Global Warming. Goats and other livestock are analyzed within this context, for their survivability and production potentials. Plant and livestock management methods are presented as solutions to increasing desertification. Political vulnerabilities from Globalization and peak oil production are discussed, and biodiversity is suggested as a means of preparation and transformation from vulnerabilities. Data is used from The Intergovernmental Panel on Climate Change (IPCC); the National Oceanic and Atmospheric Administration (NOAA); the National Sustainable Agriculture Information Service (ATTRA); the Centers for Disease Control and Prevention (CDC); the Central Intelligence Agency (CIA); the U.S. Department of Agriculture (USDA); the Food and Agriculture Organization of the United Nations (FAO); and the Energy Information Administration (EIA) along with other sources.

GOATS IN THE TWENTY-FIRST CENTURY

The objective of this paper is to explore the sustainability of goats vs. other livestock, in context of increasing climate extremes, desertification and fossil fuel consumption; and to recommend the higher survivability and diversity of goats as an integral livestock production source. This is important because of how globalization in the U.S. has focused its milk and meat protein sources mainly on one species of livestock, livestock that consumes a limited number of autotrophic species – mostly grass and corn monocots. Other concerns are leading causes of death and lower life expectancy of Americans - resulting from a high saturated fat diet that contains growth hormones and carcinogens. In the face of catastrophic global warming, climate extremes create vulnerabilities to cultures built on a single species of either plants or animals. Drought has recently created a limited corn crop, which resulted in high consumer milk and beef prices.

It is generally known that goats have a broad niche that metabolizes a wide variety of autotrophic species; including gymnosperms, angiosperms and some fern autotrophs. In contrast, marbled meat is mostly produced by monocot angiosperms, which are produced mostly by farming operations subject to capitalism and fossil fuel usages.

The reader should consider the facts that relate to climate extremes, desertification and fossil fuel longevity, and understand how to be better prepared for catastrophe. More variety of meat sources should be considered. The paper will explore the effects of global warming, climate extremes and desertification on plant and animal species; the diet and sustainability of goats vs. other livestock; and the product-composition of goats vs. that of other livestock. It will discuss preparation for peak oil production – using scenarios. My conclusion will reflect the superiority of goats in these contexts, and how goats sustain a healthier and more reliable meat source for humans.

METHODS

Online sources are researched for data and citation. Field observations of my own goats are used, and their diet and sustainability. Observations of neighboring cattlemen here in Missouri are made, as they managed their cattle pastures. Biology textbooks are cited.

RESULTS AND DISCUSSION

CLIMATE EXTREMES FROM GLOBAL WARMING

Global Warming occurs approximately every 100,000 years. According to NOAA earth's changing relationship with the sun causes fluxuations in solar radiation. According to Raven et al, (2011) biomass decay is the main source of carbon fluxuation in the atmosphere, and it changes with the solar radiation (freeze/thaw cycles of the planet). Aside from human-induced carbon dioxide emissions there is a current cyclical global warming event in progress. According to Raven et al (2011) carbon dioxide in the atmosphere does not interfere with the arrival of the sun's radiant energy at short wavelengths, (but) it retards the rate at which energy travels away from earth at long wave lengths into space. Whether considered completely natural or partly human-induced, carbon dioxide levels are reported to be higher than ever before analyzed. Higher carbon dioxide levels are associated with higher atmospheric temperatures, as carbon dioxide traps outgoing infrared radiation that radiates out from the planet's surface – warming the atmosphere. According to Lutgens and Tarbuck (2010) warm air stores more energy (in water vapor) than cold air - energy that is absorbed (required) as water evaporates (changes) from a liquid state to a gaseous state. This is latent energy - that increases with rising global temperatures in the atmosphere. This energy gets released as it cools adiabatically - when lighter air containing water vapor is displaced by heavier dry air - forcing the air diluted with water vapor upward until lower atmospheric pressure cools it adiabatically (releasing latent energy and precipitation). This increase of temperature and latent energy is responsible for climate extremes and extreme meteorological events, extremes which contribute to extinction of species. Figure 1, from NOAA, represents data from the Antarctica ice core samples, samples that prove global warming is a cyclical event.

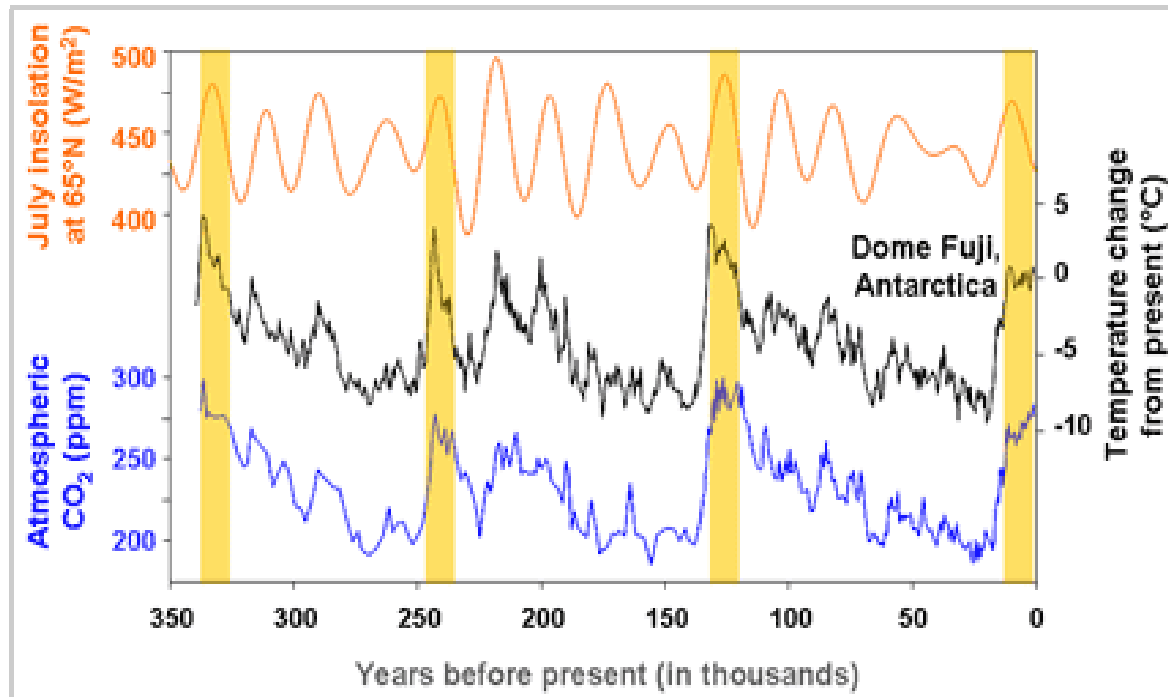


Figure 1. This shows the carbon dioxide and temperature cycles of cyclical Global Warming (vertical yellow bars are global warming spikes).

Excess precipitation is released in the rain shadows of coastal mountain ranges as diluted air loses its water vapor while rising over these mountains. The air becomes hotter and drier (from global warming), flowing inland where it evaporates an increasing amount of moisture from a region – causing drought. This is the basis for the IPCC’s “medium confidence” drought predictions for intracontinental regions such as central North America – through the twenty first century (IPCC, 2012). Raven et al (2011) go on to cite reports stating that half of all plant species and two thirds of all vertebrates may perish by year twenty-one hundred. Included are species that we depend on for food, medicine, clothing and shelter. This creates vulnerability from genetic bottlenecks or drift, and the loss of genetic variation, and creates the need for management of increasing desertification.

DESERTIFICATION

Desertification is the spread of deserts, typically in semi-arid regions, largely because of poor land management and more recently because of global warming. Climate extremes trigger desertification, as droughts interfere with farming, livestock production and wildlife. The USDA constructed a global map of desertification vulnerability.

Figure 2 shows a map depicting drought and temperature related desertification, but not the loss of species from human expansion. Raven, et al (2011) point out that human expansion into humid species-rich (hot spot) regions are responsible for the majority of species loss. Species-richness is more concentrated in humid areas. This paper focuses on species loss from desertification and not from human expansion.

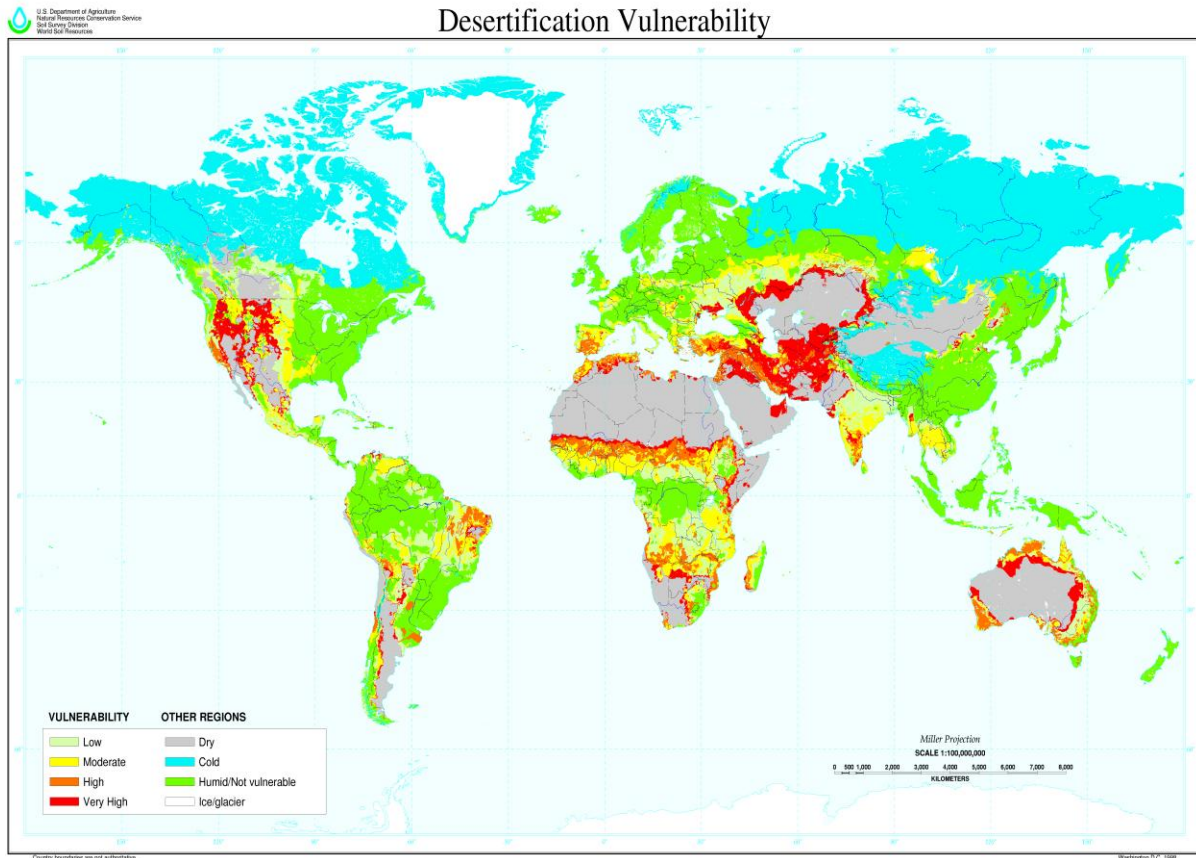


Figure 2. Desertification Vulnerability is depicted in red. These areas are non-humid climates, which experience loss of species because of vulnerable plant metabolism thresholds of rising temperatures and mismanagement of herbivores.

The IPCC outlines Adaptation and Disaster Risk Management Approaches for a Changing Climate. Some of the important approaches are; preparation, transformation and reduction of vulnerability (figures 3 & 4).

FAO maps show global gridded livestock density per species. This data reveals the level of livestock diversity worldwide. The U.S. exhibits high densities of cattle (*Bovinae bos*) and pigs (*Sus scrofa*). India exhibits high densities of cattle, sheep (*Ovis aries*) and goats. China exhibits the most diversity with high densities of cattle, sheep, goats and pigs. South America shows high cattle density. There is a need for diversity of livestock species in the U.S. and some other countries, diversity that reduces vulnerability to drought and invasive plant species. Goats are a solution. They occupy a wide niche in that they utilize more species of plants. When managed they not only maintain the species richness of pasture land, but also human survivability; when desertification of global warming limits the diet of other ruminants. Goats offer a means for the farmer/rancher to utilize many autotrophic plants currently not being exploited by other livestock (Figures 5, 6, 7 & 8).

MEAT COMPOSITION

The CDC data reveals that heart disease and cancer remain the first and second causes of death in the U.S. respectively since 1935. Diet related heart disease is contributed to the intake of saturated fats and sedentary lifestyles (Weiss, 2009). Consuming goat meat can help reduce saturated fat intake, and help to avoid the bad low density lipoprotein (LDL) particle sizes in the blood of consumers (Figure 9).

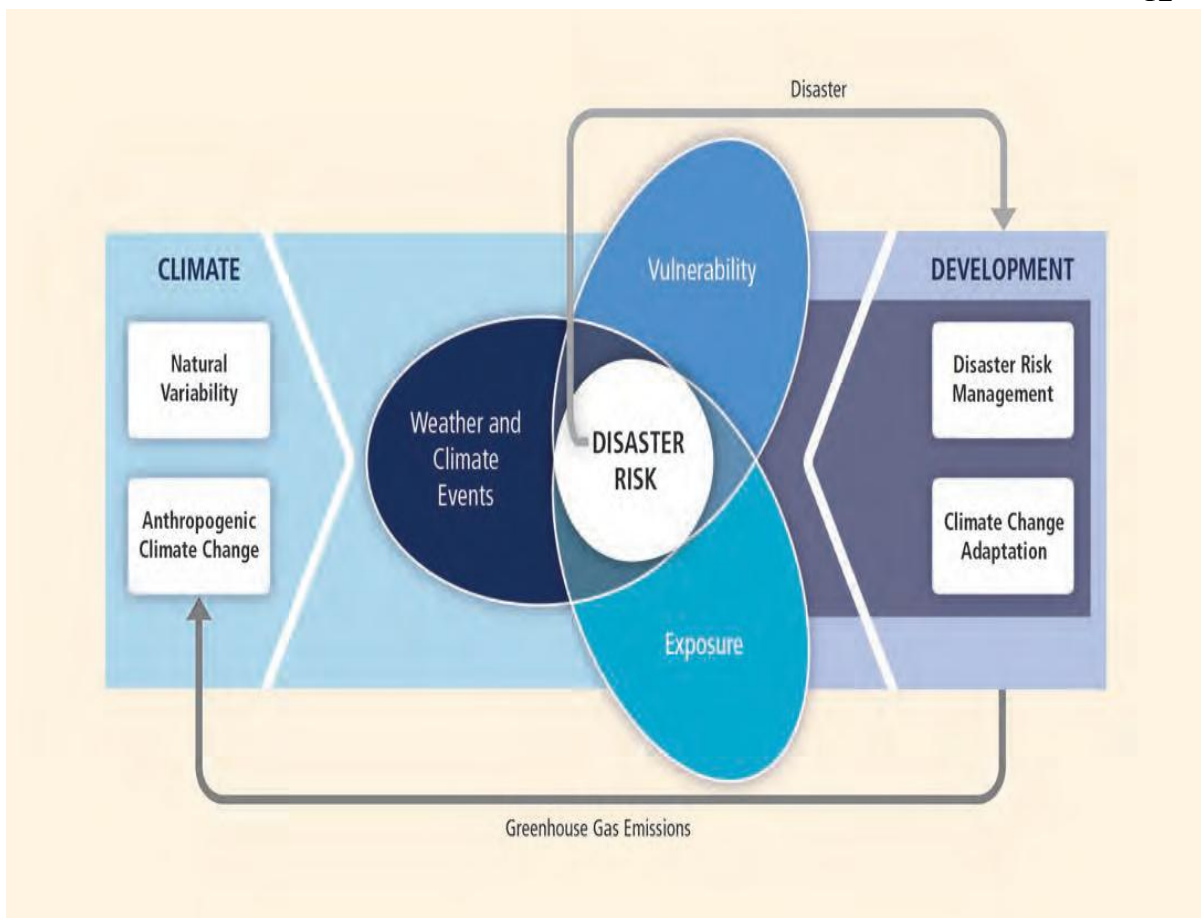


Figure 3. This IPCC illustration “assesses how exposure and vulnerability to weather and climate events determine impacts and the likelihood of disasters (disaster risk). It evaluates the influence of natural climate variability and anthropogenic climate change on climate extremes and other weather and climate events that can contribute to disasters, as well as the exposure and vulnerability of human society and natural ecosystems. And considers the role of development in trends in exposure and vulnerability, implications for disaster risk, and interactions between disasters and development. The illustration depicts how disaster risk management and adaptation to climate change can reduce exposure and vulnerability to weather and climate events and thus reduce disaster risk, as well as increase resilience to the risks that cannot be eliminated”.

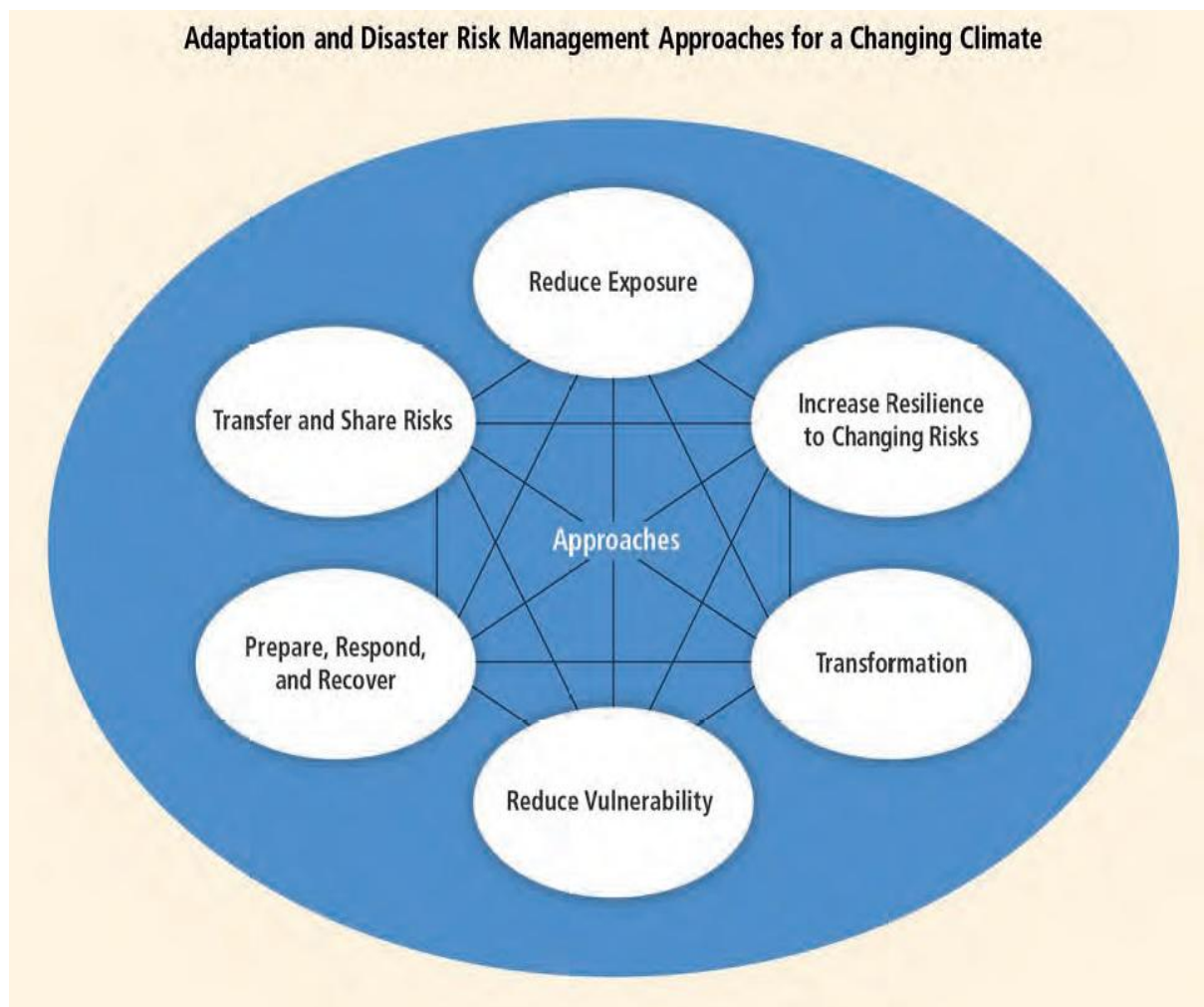


Figure 4. This illustration depicts IPCC “adaptation and disaster risk management approaches for reducing and managing disaster risk in a changing climate. It assesses a wide range of complementary adaptation and disaster risk management approaches that can reduce the risks of climate extremes and disasters and increase resilience to remaining risks as they change over time. These approaches can be overlapping and can be pursued simultaneously”.

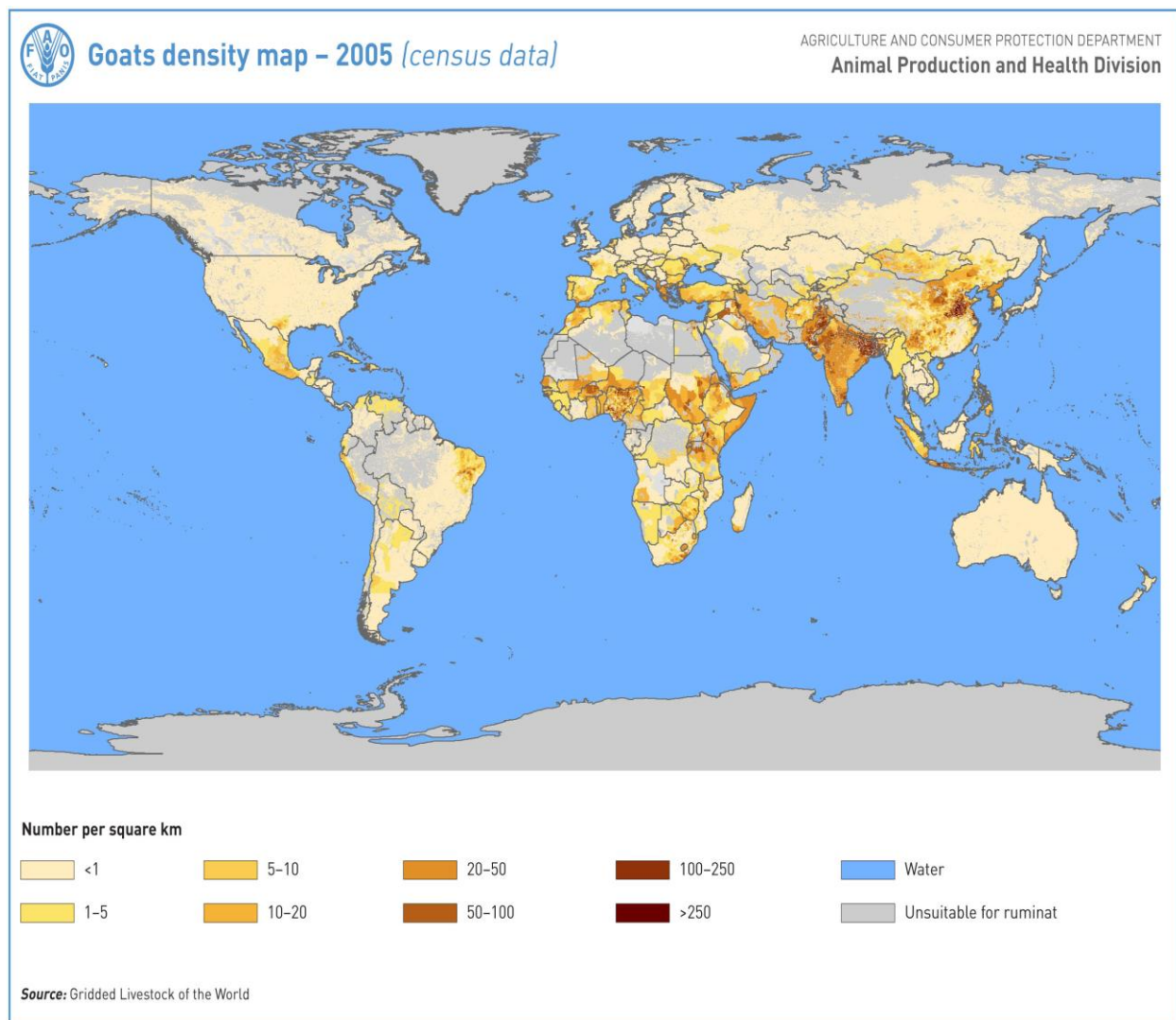


Figure 5. Global Goat Density (darkest areas).

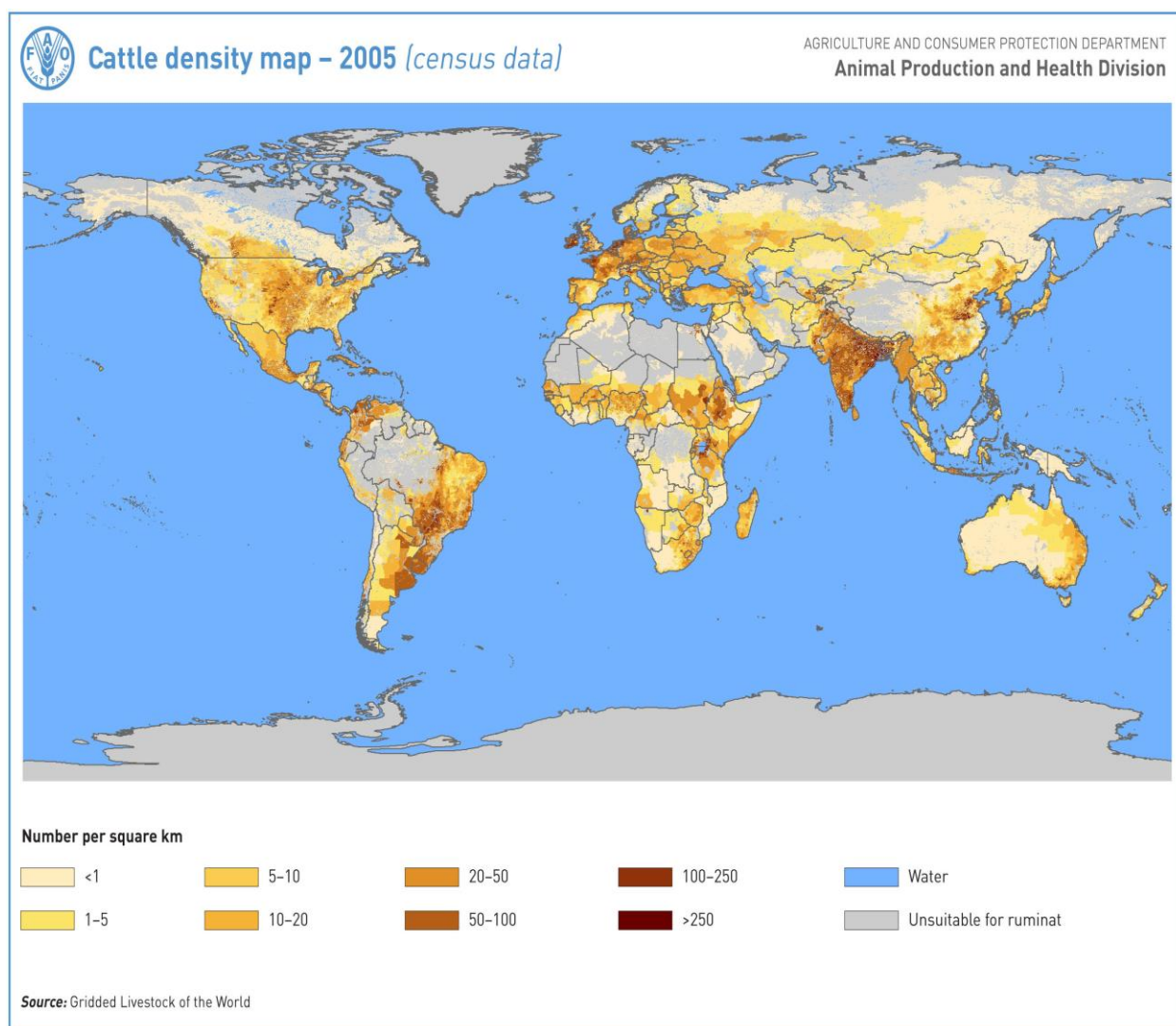


Figure 6. Global Cattle Density (darkest areas).

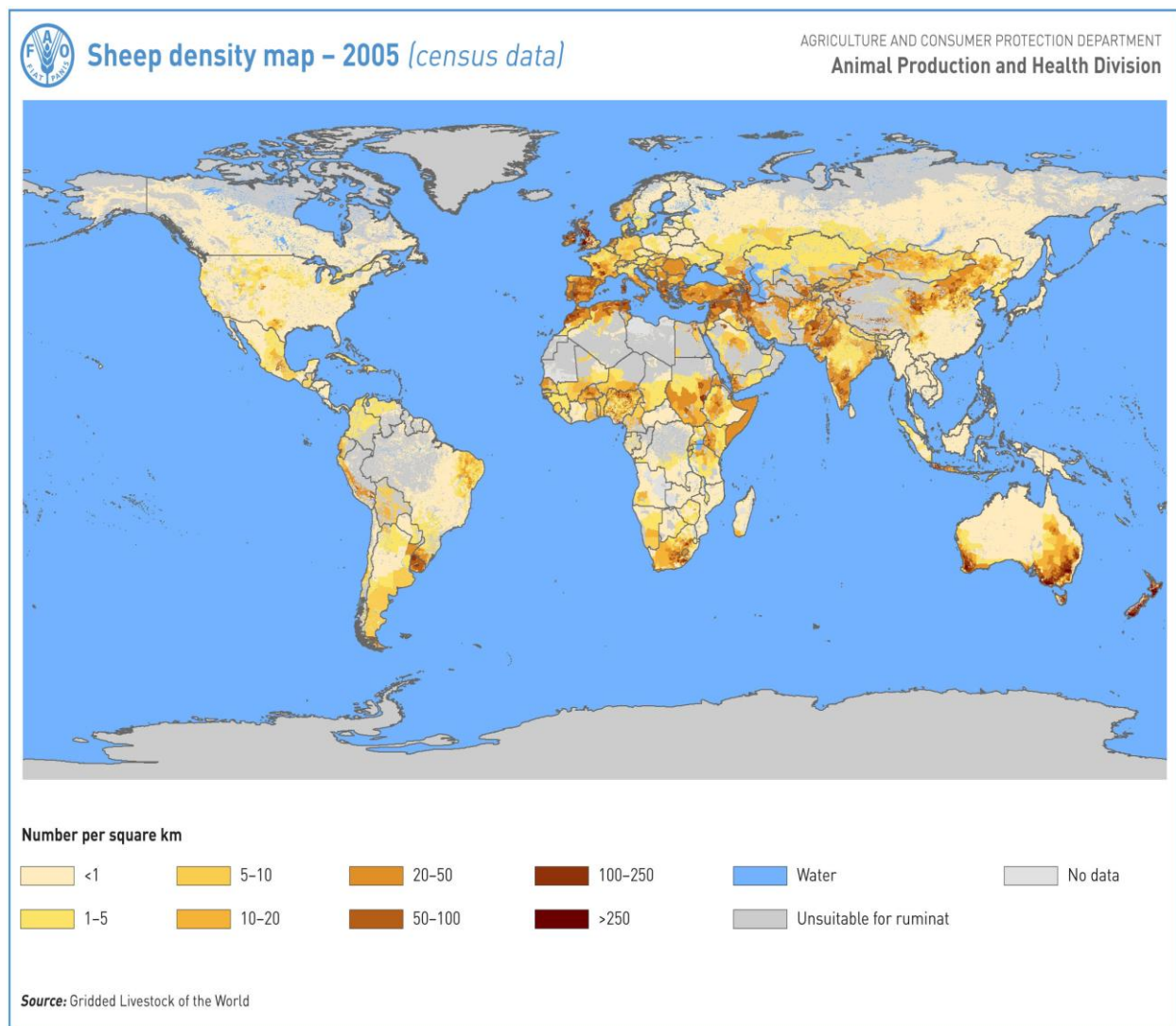


Figure 7. Global Sheep Density (darkest areas).

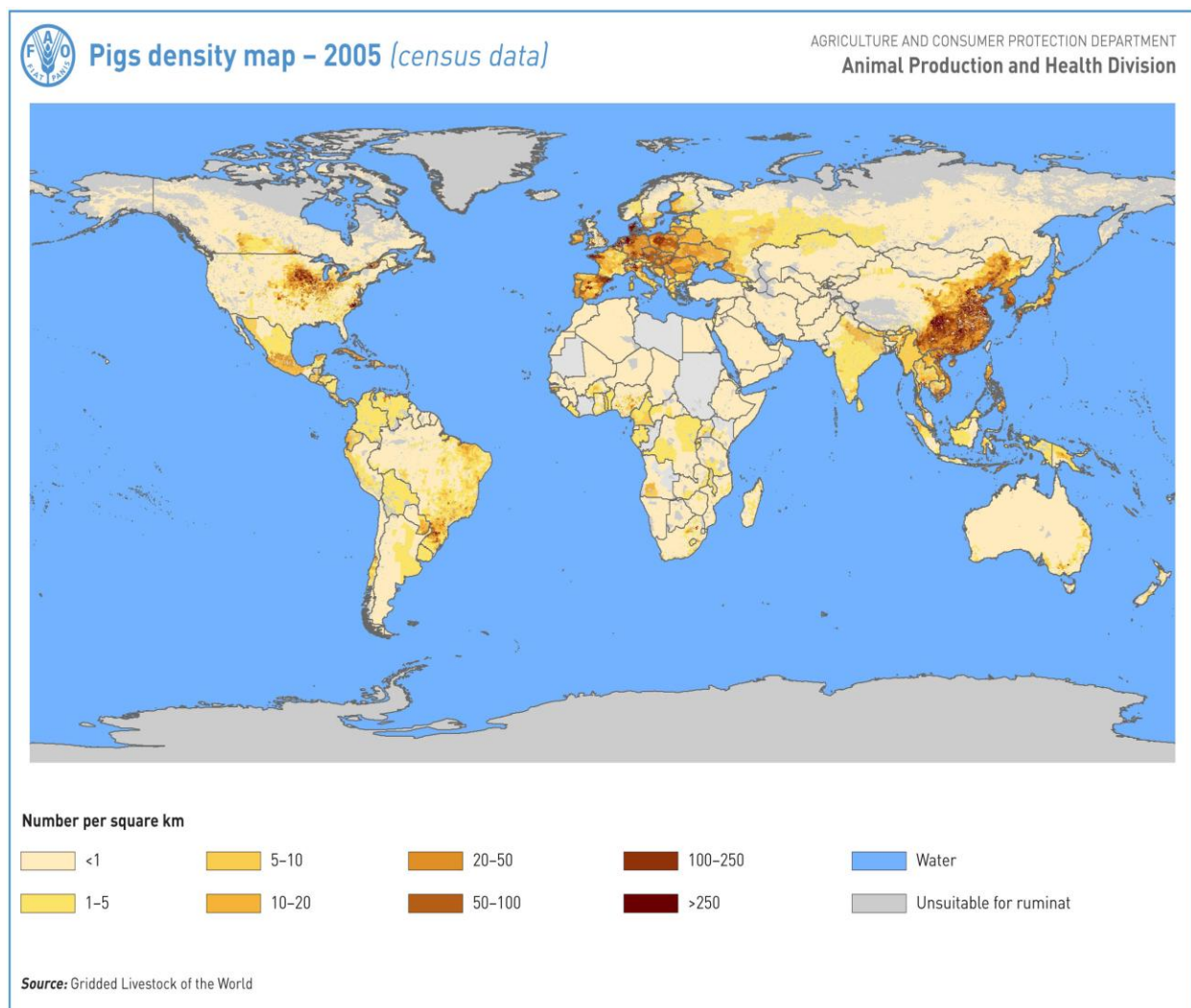


Figure 8. Global Pig Density (darkest areas).

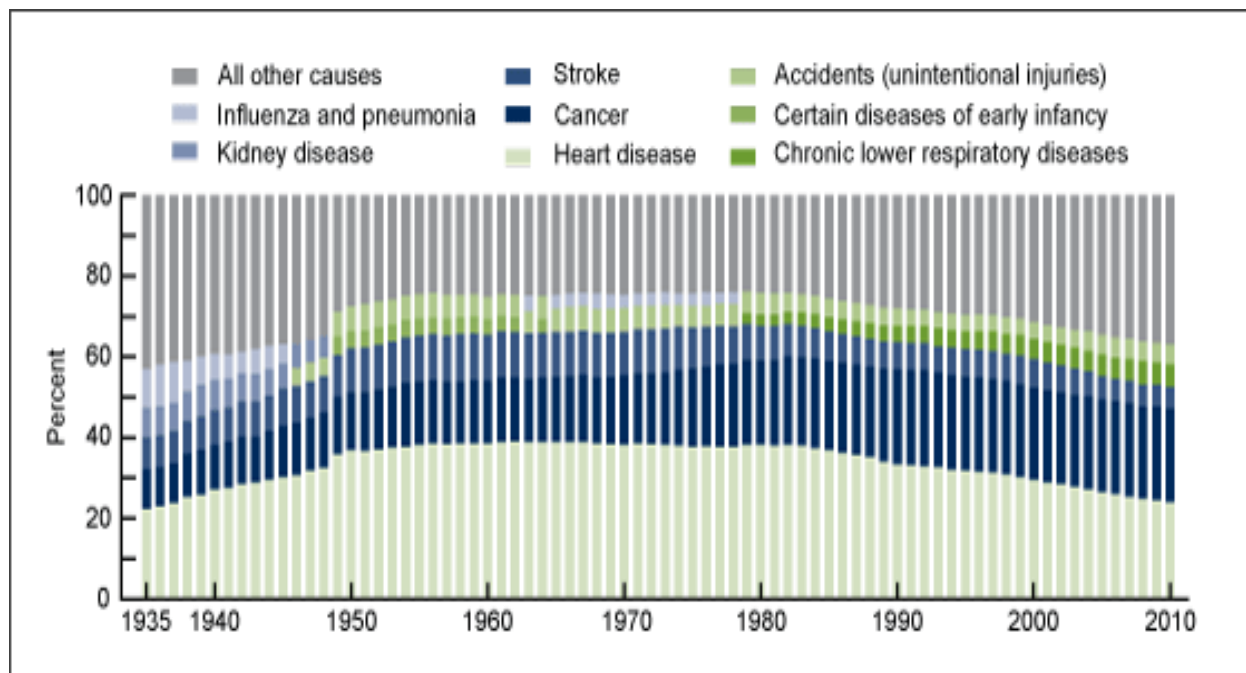


Figure 9. Causes of Death in the U.S. from 1935 to 2010 (CDC). Note that heart disease and cancer represents nearly fifty percent of the current causes of death in the U.S.

The CIA records the U.S. as fifty-first of two hundred twenty-two countries for life expectancy longevity. These chronic degenerative diseases are largely due to saturated fats found in marbled meat. Growth hormones and any other fat-soluble carcinogens may become stored in fatty tissues of livestock, and more so in marbled meats. According to Coffey, Hale and Wells, (2004), goat meat does not marble. Instead, fat in goats accumulates subcutaneously, or in internal fat bodies, and can be removed with the hide and entrails. The competition to produce milk and marbled meat results in an increase in steroid and growth hormone usage. Farmers use pesticides for the same reasons, and these chemicals go into the livestock feed. The resulting products are contributors to the chronic degenerative diseases of heart disease and cancer (Rifkin, 1996). The CDC points out that the antibiotics used in cattle comprise eighty percent of all antibiotics used in the U.S., antibiotics used as growth promoters which cause bacteria to be resistant; and thus cause more infections in human consumers. Europe has outlawed the use of animal antibiotics for this reason (CDC, 2013).

Alabama A & M and Auburn Universities produced data on the meat composition of different livestock. Goat meat has a lower calorie and fat content than beef, pork, lamb or chicken (*Gallus gallus*). Yet it has nearly an equal amount of protein. This study also points out that goat meat has a higher iron and potassium content, but lower sodium content. Lower cholesterol content in goat meat is reported also. This data shows that beef, pork and mutton (lamb meat) is over three times as high in saturated fat as goat meat. This translates into high chronic degenerative disease and lower longevity for humans (Weiss, 2009). Overall, goat meat is much healthier in that it lowers your fat, saturated fat and cholesterol intake (Table 1).

Table 1. Nutrient Composition of Goat and Other Types of Meat ^{[1], [2]}					
Nutrient	Goat	Chicken	Beef	Pork	Lamb
Calories	122	162	179	180	175
Fat (g)	2.6	6.3	7.9	8.2	8.1
Saturated Fat (g)	0.79	1.7	3.0	2.9	2.9
Protein (g)	23	25	25	25	24
Cholesterol (mg)	63.8	76.0	73.1	73.1	78.2
^[1] Per 3 oz. of cooked meat					
^[2] USDA Nutrient Database for Standard Reference, Release 14 (2001)					

MILK COMPOSITION

According to the University of California-Davis (UC Davis), goat's milk has eleven to twenty mg of cholesterol per one hundred grams of milk vs. fourteen to seventeen mg in cow's milk. "Consuming cholesterol is not as damaging as consuming saturated fat. It is the saturated fat intake that does most of the cardiovascular damage – and causes obesity related cancers" (Sizer, 2011). UC Davis data shows that goat's milk lacks agglutinating euglobulin, which prevents cream separation at room temperatures; and also that lactalbumin and casein micelles proteins are dissimilar in structure in goat's milk compared to cow's milk. Allergies to cow's milk are remedied by consuming goat's milk's dissimilar protein structures. And allergies from goat's milk are similarly remedied by cow's milk. UC Davis data reveals that goat's milk is much lower in vitamin B12 than cow's milk, but comparable to B12 in human breast milk. In addition, copper and iron supplements are needed when relying exclusively on goat's milk, because of anemia development in infants and bottle feeders. This can be remedied by consuming ground goat meat in the diet. Data shows that ribonuclease and lysozyme enzymes are higher in goat's milk (Table 2).

The following table from Oregon State University compares the average fat, milk serum protein and carbohydrate composition of cow's, goat's and sheep's milk. This data show that sheep's milk fat is much higher than either cow's or goat's milk averages, and inferior to either goat's or cow's milk in this respect (Table 3).

TABLE 2. Average vitamin content of cow, goat and human milk.

Vitamin	Cow	Goat	Human
Vitamin A(1)(2)	1560.0 (1380)	2074.0 (1850)	1898.0 (2410)
Vitamin D	33	23.7	22.0
Thiamine	0.44 (0.38)	0.40 (0.48)	0.16 (0.14)
Riboflavin	1.75 (1.61)	1.84 (1.38)	0.36 (0.36)
Nicotinic Acid	0.94 (0.84)	1.87 (2.7)	1.47 (1.77)
Vitamin B 6	0.64 (0.42)	0.07 (0.46)	0.10 (0.11)
Pantotheine	3.46 (3.13)	3.44 (3.1)	1.84 (2.23)
Biotin	0.031	0.039	0.008
Folic Acid	0.0028 (0.005)	0.0024 (0.001)	0.0020 (0.005)
Vitamin B 12	0.0043 (0.0036)	0.0006 (0.00065)	0.0003 (0.00045)
Ascorbic Acid	21.1 (14.7)	15.0 (13,0)	43.0 (50)
Choline	121.0	150.0	90.0
Inositol	110.0	210.0	330.0

(1) Vitamin A expressed in International Units/liter; all others as mg/liter.

(2) Numbers in () s are from the USDA Handbook 8-1 (1976).

Table 3.—Average composition (%) of milk from different species

<u>Animal</u>	<u>Fat</u>	<u>Serum Protein</u>	<u>Carbohydrate</u>
Cow	3.9	0.6	4.6
Goat	4.5	0.6	4.3
Sheep	7.5	1.0	4.6

HIDE

“Split cowhide comes from the underlying layer of a cow's skin. By running the wet hide through a splitter, the tanner yields two or more "splits" of leather, depending on (the) initial thickness of the hide” (Magee, 2013). Goat hide is more durable when left unsplit. Most cowhide leather is split for use in clothing, upholstery and some footwear applications. Things like saddles and work boots require thicker leather, but most leather products are produced from a splitting thickness that resembles the thickness of goat hide that has not been split. Using the natural thickness of goat hide eliminates the expense of splitting in many applications. Therefore goat hide has a grain similar to cow hide but is less expensive to produce (Figure 10).

CASHMERE PRODUCTION

Cashmere is one of the softest, warmest, and longest lasting materials on the market today according to Purcell (1996), of the Trade Environment Database Projects (TED). She goes on to describe the product further. Cashmere fibers become softer as they are worn more. Cashmere is said to be eight times warmer than sheep's wool, and about that many times softer. Cashmere is also one of the most expensive cloths on the market today. Cashmere originates from Kashmiri goats found in the Himalayas. Cashmere wool comes from the downy undercoat that grows on goats from midsummer to winter. The quality varies from goat to goat. The long hairs on goats protect the cashmere down from the elements. It is removed each spring by shearing or gradual combing of the goat's hair. Each goat produces about three to eight ounces of cashmere per year. The average single ply women's sweater requires approximately ten ounces of wool, which is equivalent to about three or four individual goat shearings. The quality of cashmere wool is measured by its length, texture, and the diameter of the fiber. The quality is affected by the climate and nutrients that the goats consume. The climate and geography of Mongolia is especially suited for herding goats because *they thrive in*



Figure 10. This shows a very expensive leather splitter machine.

harsh dry mountainous climates. The highest quality of wool is found in these climates. Goats cannot grow the downy coats that produce cashmere in moderate climates (Purcell, 1996).

MOHAIR PRODUCTION

According to Oklahoma State University, angora goats produce approximately ten point six lbs of mohair fiber per year from semi-annual shearing, with a staple length of twelve to fifteen cm long. Data reveals that the chemical composition of mohair is similar but differs from wool in smoothness and scale. Mohair lacks the felting properties of wool (lacks cohesiveness of fibers). It is similar to coarse wool. It is strong, elastic, has considerable luster and takes dye very well. It is considered valuable for upholstery material and for applications requiring strength, beauty and durability (Oklahoma State University, 2008).

MANAGEMENT OF DESERTIFICATION

Livestock species have different niches that consume a variety of plants.

- ✓ Goats eat approximately seventy-five percent browse (brush), twenty percent weeds and forbs, and five percent grass - when they have their preferred diet.
- ✓ Cattle eat approximately eighty-five percent grass, ten percent weeds and forbs, and five percent browse – when they have their preferred diet.
- ✓ Sheep eat approximately forty-five percent weeds and forbs, thirty-five percent grass and twenty percent browse - when they have their preferred diet.
- ✓ Pigs eat a diet of ninety percent plants and roots, and ten percent animal matter.

The sheep diet is probably the most diverse of all ruminants. They consume nearly equal amounts of browse, forbs and grasses. Like cattle, their diet diversity is vulnerable to desertification when plant species-richness is threatened (Figure 11).

According to the Merck Veterinary Manual, goats can tolerate 20 times the amount of weeds and forbs that contain alkaloids with pyrrolizidine bases; when compared to other ruminants. A plant that kills goats usually kills all other ruminants, but plants that kill other ruminants do not always kill goats (Kahn, 2005). Observing feral species helps in management, by understanding sustainability in context of climate extremes and desertification.

FERAL GOATS

The Australian government has a feral goat (*C. hircus*) management program that states: “feral goats have a varied diet – leaves, twigs, bark, flowers, fruit and roots. They will eat most plant types in pastoral regions, and often consume vegetation that is avoided by sheep and cattle” (Commonwealth of Australia, 2011). Feral goats and mountain goats (*Oreamnos americanus*) demonstrate their ability to forage where other stock cannot (Figures 12 & 13).

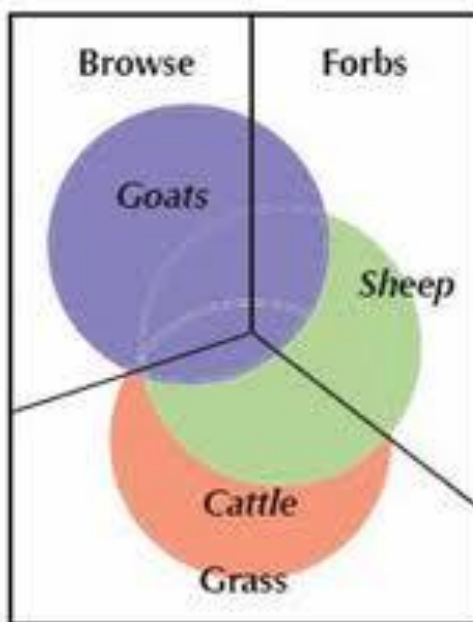


Figure 11. Livestock diet parameters are illustrated in this figure. Goats prefer mostly browse (brush). Cattle prefer mostly grass. Sheep prefer mostly weeds, forbs and grass.



Figure 12. Feral Goats demonstrate their ability to forage high from the ground.



Figure 13. Mountain Goats Foraging on cliffs where cattle cannot feed.

FERAL PIGS

Feral pigs (*S. scrofa*) exist all over the globe. Britain describes their diet as ninety percent plants and ten percent animal matter. They live on roots, bulbs and tubers, fruit and berries. The animal matter diet includes mice, bird's eggs, snakes, lizards, worms, beetles, centipedes and carrion. Their diet changes with the seasons to include beech mast, chestnuts and olives. They also raid agriculture crops such as maize, turnips and potatoes (British Wild Boar, 2011). Pig meat is more susceptible to parasite cysts that cause trichinosis; they can only forage knee high, and no one milks a pig for milk. Feral pigs are a hearty species but the meat is higher in saturated fat. In comparison to goats, pigs have inferior meat, and no milk available to humans (Figure 14).

BIG HORN SHEEP

Described by a Canadian source "Mountain sheep (*Ovis canadensis*) prefer green forage and move up or down slope, or to different aspects of the slope for more palatable forage. Important foods are wheatgrass (*Elytrigia elongate*), fescues (*Festuca*), bluegrasses (*Poa*) and sedges (*Cyperaceae*). Clover (*Trifolium*), lupines (*Lupinus*), pasture sage (*Artemisia frigid*), cinquefoil (*Potentilla nivea*) and dwarf willow (*Salix herbacea*) are consumed when available" (Canadian Geographic, 2002). Evaluating the wild sheep diet reveals the diversity of their diet. However, where goats exceed sheep survivability is in the goat's ability to consume more woody plants and brush, in a desertified setting. Figure 15 shows an example of big horn sheep in Colorado.



Figure 14. Feral Hogs in Texas



Figure 15. Big Horn Sheep of Colorado

There is a strong correlation between invasive plants and the reduced income of ranchers. According to Raven, et al (2011) plant species often respond to rising temperature by shifting their geographic ranges - migrating within their environments. Extreme climate changes and extreme meteorological events are the predicted result of global warming; which include temperature and precipitation anomalies such as drought and heat waves (causing the environmental shifts of plant species). They go on to explain how higher plant species-richness (many species present) helps plants to withstand drought. This translates into a higher herbivore species-richness, because of the differing diet niches of herbivores. Plants have different metabolic thresholds of moisture and temperature, such as C3 or C4 plant metabolisms. As the globe warms it changes plant species-richness in vulnerable areas. This allows invasive plants to invade a vulnerable threshold region. The consequences are more serious in the cattle diet because it is less diverse. According to Colorado State University (CSU), leafy spurge (*Euphorbia esula*) invades grazing regions in Colorado - costing the cattle industry immensely. CSU cites Montana State University's (MSU) documentation of how goats can consume a fifty percent diet of leafy spurge. Partial transformation and integration is illustrated by the following Montana goat producer. "Noxious weeds are a significant and increasing problem for cattle grazers in the northern (United) States, and the goats offer one solution to the ecological challenge. In recent decades as sheep numbers have declined in Montana, weeds, brush and forbs have proliferated. Because cattle prefer grasses over brush and weeds, woody or thorny plants like multiflora roses (*Rosa multiflora*) and bitter weeds like knapweed (*Centaurea diffusa*) and spurge have multiplied. The goats will walk (or rather run!) through belly-deep grass to demolish a wild rose bush (*Rosa spp.* and *Rosa acicularis*), and will consume knapweed flower heads with vigor, essentially stopping the spread of seeds" (Tucker, 2002 by ATTRA). However, if unmanaged goats will reduce the species-richness of a region. Their wide

appetites enable them to overgraze most plants - to the point that many species may be killed.

According to United Nations sources (UN, 1999) biodiversity is threatened by overgrazing and the overexploitation of animals (especially goats) and plants. The ecological health of the grasslands is very important because overgrazing destroys pastures as well as wild species and biodiversity.

The UN refers to Mongolia as an example. Desertification is the largest environmental threat to the cashmere industry in Mongolia. Many herders are losing their connection with the land, and over-grazing is one result of this loss. Over-grazing leads to desertification. Almost thirty percent of Mongolia's territory has the conditions necessary for desertification to occur. One percent of Mongolia is severely affected by desertification, three percent is considerably affected, twenty one percent is affected to a medium extent, and seventy-five percent of Mongolia's land mass is slightly effected by desertification. About thirteen percent of desertification is due to nature and the other *eighty-seven percent of desertification in Mongolia is caused by humans*. Over the last four decades, the area of land covered by sand has increased eight point seven percent. Desertification has affected thirty percent of pasture lands in Mongolia. Pasture lands account for a total of eighty percent of Mongolia's land mass. The population of goats (where cashmere comes from) is a problem because *goats destroy grasslands and soil* (Heikkila, 1998 by TED). These environmental problems are caused to a large extent by the very thing that Mongolians make their living by doing. According to the TED Globalization may lead to a worsening of this problem because of the need to produce more and more products and also because the connection to the land is lost.

There are different approaches to the prevention of desertification.

Holistic Planned Grazing is a less popular and less applicable method (except for open

range regions) introduced by the Savory Institute. This grazing method involves mimicking the natural migration patterns and populations of livestock, and the natural predator pressures of predation. It involves annual rotation based on a season. Large populations of livestock are involved in the brief but intense grazing of large regions of open range. The annual timing between grazing is more thorough in controlling parasites, because it allows more time for the land to rid itself of larva between grazing seasons (Blasiak, 2012).

The more conventional approach to preventing desertification is to maintain foliage and plant species-richness by rotating livestock. This management method entails brief pasture and range usage intervals - based on height and health of the plant biomass and not the season. Parasites are managed by maintaining foliage higher than four inches tall. This prevents the consumption of parasite larva that climb up the foliage in order to be eaten by host herbivores (Coffey et al, 2004). This conventional approach is most feasible for smaller producers and smaller acreages where livestock cannot migrate because of fencing.

Australia documents how the wild dingo dogs reduce the populations of feral goats. (Commonwealth of Australia, 2011). Coyotes in the U.S. have a similar effect on goats if not managed. This type of management (allowing dogs and coyotes) is good if the feral goat is overstocked in a region, but adverse to the integration of goats into a region that needs diversity.

Plant species-richness is maintained by managing a balance of herbivory, which consume all plant species in equal amounts. This maintains species-richness and prevents an invasive plant species from taking over a region. Combining goats with cattle is a balancing of herbivory (Coffey et al, 2004). Inevitably, invasive plants emerge, based on compromised metabolism thresholds, caused by rising global temperatures, but drought resistance is maintained.

My field observations reveal how neighboring cattlemen use brush mowers to

maintain the balance of plant species in cattle pastures. The brush takes over as cows reduce the competition of grasses. Goats perform the same service for free. Machinery and labor costs of mowing are replaced with hotwire electric fencing, and predation protection such as guard dogs or donkeys - to defend the goats against coyotes and wild dogs (Coffey et al, 2004).

POLITICAL VULNERABILITY

Politics reveals the struggles and vulnerabilities of cultures built on a single-species. The following quote is from the New York Times. Washington - “Three big intertwined but rival agribusinesses – corn farmers, meat and poultry producers, and biofuel refineries – are in a political fight to protect their interests as a drought ravages corn producers and industrial consumers alike” (Cushman Jr., 2012).

The movie “Food Inc.” documents the U.S.’ vulnerability to globalization and capitalism, in context of livestock production based on corn. It documents the E-coli hazards of single-species cattle feed. The U.S. sovereignty is made vulnerable to globalization by reliance on foreign resources such as ammonium nitrate fertilizer. The meat and milk industries become dependent on the resulting monocot corn crop (POV, 2013).

The U.S. and other countries will be influenced in the future by decreasing supplies of crude oil according to the geological community (Long et al, 2004). T. Boone Pickens is the geologist that supports transformation to natural gas, as an alternative to peaking oil production (Montaigne, 2011). Integrating goats into the U.S. prior to these realities reduces vulnerability to the loss of fuel-based meat sources – meat sources comprising eighty percent of all fed cattle in the U.S. (National Cattleman’s Beef Association, 2013). The feed sources are centered on corn and grain production. Losing the ability to fertilize pasture lands would add to these reduced meat sources, and desertify pastures without proper management. Even though peak oil production may be decades away, we can prepare gradually for it by starting to integrate

more goats now. Long et al give USGS scenarios of when peak oil production will decline (Figure 16).

According to Pennsylvania State University (PSU) “Goat is the most highly consumed meat in the world; and more goat’s milk is consumed worldwide than cow’s milk” (PSU, 2000). Therefore, immigration reform increases the diversity of livestock products as it increases culture that prefers goat products to either beef, pork or chicken. On 1/3/2013, T.S. White’s Sheep and Goat Sale described the sheep and goat market as “supply moderate, demand very good”. Fifty-nine percent of the eleven hundred seventeen animals sold were goats. This shows that there is room and demand for diversity in the meat market in Diamond, Missouri (White, by USDA, 2013).

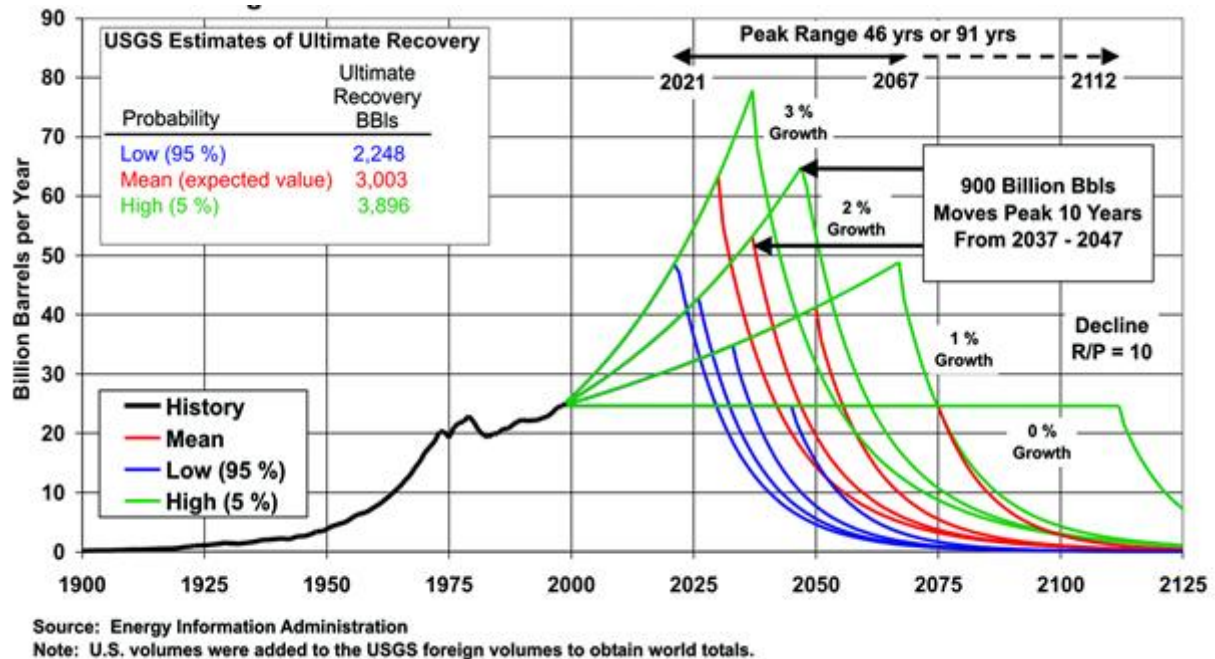


Figure 16. Twelve EIA World Conventional Oil Production Scenarios. These portray oil production variables such as one percent, two percent or three percent increases in the number of barrels produced. They take into consideration newly discovered oil sources. Except for tar sand type sources most of the oil sources are geologically known and already surveyed for their future potentials (give or take nine-hundred billion barrels). This variance will only effect the peak oil production by ten years either direction. Goats are a way to prepare, along with the transformation to natural gas.

CONCLUSION

Goats are less vulnerable to climate extremes and desertification than most species used for meat and milk production in the U.S. A goat's diet is more sustainable in drought-induced desertification. Goat meat is healthier in terms of reducing chronic degenerative diseases such as heart disease, and cancers from carcinogens and obesity; diseases that are responsible for the majority of deaths and lower life expectancies in the U.S. Goat meat is leanest and does not harbor as many fat-soluble growth hormones and carcinogens, because goat meat does not marble. Goat meat is higher in iron and lower in sodium than other meats. Goat's milk is comparable to human breast milk in vitamin content, but lower than cow's milk in B12. Iron and copper supplements are needed when relying exclusively on goat's milk as an infant nursing source. Goat's milk is slightly higher in cholesterol than cow's milk, but insignificant compared to the saturated fat discrepancies between the different species.

The IPCC recommends preparation for climate extremes (drought), rising global temperatures and the extreme meteorological events. Managed goat integration increases drought resistance and species-richness of both plants and animals, and prepares for future energy shortages – and thus human survivability. The world consumes mostly goat's milk and goat meat in comparison to the U.S.' cow's milk, beef, pork and chicken. Global life expectancies reflect these differences between high-fat and low-fat diet centered cultures. Preparation for the future must include the integral use of goats alongside sheep and cattle; to diversify livestock and help stop desertification from the climate extremes of global warming - and the vulnerabilities of decreasing energy resources.

REFERENCES

- Blasiak, Robert (2012). Reversing Desertification with Livestock. Retrieved from <http://ourworld.unu.edu/en/reversing-desertification-with-livestock/>
- British Wild Boar (2011). Diet.
Retrieved from <http://www.britishwildboar.org.uk/index.htm?profile.html>.
- Cahn, Cynthia M. (Ed.). (2005). The Merck Veterinary Manual – Ninth edition. Published by Merck & Co., Inc. White House Station, N.J, USA.
- Canadian Geographic (2002). Big Horn Sheep diet. Retrieved from <http://www.canadiangeographic.ca/magazine/nd02/facts.asp>
- CDC (2013). National Public Radio – March, Diane Rehm’s show.
- Coffey, Linda; Hale, Margo; Wells, Ann (2004). Goats: Sustainable Production Overview – Livestock Production Guide. National Sustainable Agriculture Information Service (ATTRA). Retrieved from www.attra.ncat.org
- Colorado State University (2013). Leafy Spurge. Retrieved from <http://www.ext.colostate.edu/pubs/natres/03107.html>
- Commonwealth of Australia (2011). The Feral Goat (*CAPRA HIRCUS*). Retrieved from <http://www.environment.gov.au/biodiversity/invasive/publications/pubs/feral-goat.pdf>
- Cushman Jr., John H. (2012). In Drought, a Debate over Quota for Ethanol. The New York Times. Retrieved from http://www.nytimes.com/2012/08/17/business/energy-environment/ethanol-quota-debated-by-corn-farmers-and-meat-industry.html?_r=1&
- Heikkila, Jari (Ed.). (1998). *Mongolia Environment*. Mongolian Conservation Newsletter. Issue 8, July-August 1998. Retrieved from <http://www1.american.edu/TED/mongolia.htm#10>

IPCC (2012). Report for Policy Makers. Retrieved from

http://ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf

Long, Gary R., Morehouse, David F., Wood, John H. (2004). Long-Term World Oil Supply Scenarios. Retrieved from

http://www.eia.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html

Lutgens, Frederick K.; Tarbuck, Edwards J. (2010). The atmosphere: an introduction to Meteorology. Published by Pearson Education Inc.

Magee, Mary Beth (2013). What is split cowhide leather. 2013 Demand Media, Inc.

Retrieved from http://www.ehow.com/about_6390536_split-cowhide-leather_.html

Mohair Production (2008). Retrieved from <http://www.ansi.okstate.edu/breeds/goats/angora/>

Montaigne, Fen. (2011). A New Pickens Plan: Good for The U.S. or Just for T. Boone?

http://e360.yale.edu/feature/a_new_pickens_plan_good_for_the_us_or_just_for_t_boone/2392/

National Cattleman's Beef Association, (2013). FACT SHEET: Feedlot Finishing Cattle Background. Retrieved from

http://www.beefusa.org/uDocs/Feedlot%20finishing%20fact%20sheet%20FINAL_4%2026%2006.pdf

PSU (2000). Meat Goat Production. Retrieved from

<http://www.caes.uga.edu/topics/sustainag/documents/MeatGoat-PennSt.pdf>

POV (2013). Food Inc. Documentary Review. Retrieved from

http://www.pbs.org/pov/foodinc/film_description.php

Purcell, Theresa (1996). Scotland and China and Cashmere Trade. TED Case Studies. Retrieved from <http://www1.american.edu/TED/mongolia.htm>

Rifkin, Jeremy (1996) The beef assembly line.

Retrieved from <http://www.columbia.edu/~lnp3/mydocs/ecology/cattle.htm>

Sizer, Frances; Whitney, Ellie (2011). Nutrition – Concepts and Controversies - Twelfth Edition.

Cengage publishing Co.

Tucker, Yvonne (2002). ATTRA (referenced above). Retrieved from www.attra.ncat.org

Weiss, Gregory L.; Lonnquist, Lynne E. (2009). The Sociology of Health, Healing,

and Illness – Sixth edition, Published by Pearson Education, Inc. Upper Saddle River, NJ.

White, T.S. (2013). Sheep and Goat Market of Diamond, Mo. Retrieved from

http://www.ams.usda.gov/mnreports/jc_ls323.txt

Figure 1. Carbon Dioxide and Temperature Cycles

Retrieved from <http://www.ncdc.noaa.gov/paleo/abrupt/data2.html>

Figure 2. Desertification Vulnerability

Retrieved from <http://soils.usda.gov/use/worldsoils/mapindex/desert.html>

Figures 3 & 4. IPCC Climate Change Management Diagrams

Retrieved from - http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

Figures 5, 6, 7 & 8. FAO Global Livestock Density Maps

Retrieved from http://www.fao.org/AG/againfo/resources/en/glw/GLW_dens.html

Figure 9. CDC Causes of Death From 1935 to 2010.

Retrieved from <http://www.cdc.gov/nchs/data/databriefs/db88.pdf>

Table 1. Nutrient Composition of Goat and Other Types of Meat

Retrieved from <http://www.aces.edu/pubs/docs/U/UNP-0061/>

Table 2. Milk Vitamin Composition of Goat, Cow and Human Breast Milk

Retrieved from <http://drinc.ucdavis.edu/goat1.htm>

Table 3. Average composition (%) of milk from different species

Retrieved from <http://extension.oregonstate.edu/catalog/pdf/em/em8908.pdf>

Figure 10. Leather Splitter Machine. Retrieved from

<http://www.made-in-china.com/showroom/belinna/offer-detailjbZEpsYCMIVq/Sell-Leather-Splitting-Machine-Tannery-Machine.html>

Figure 11. Livestock Diet Parameters

Retrieved from <http://www.swcd.mo.gov/osage/documents/MarkKennedy.pdf>

Figure 12. Feral Goat Reaching High For Forage

Retrieved from <http://www.4shared.com/all-images/2D4I7-XT/aziz1.html>

Figure 13. Mountain Goats Foraging.

Retrieved from <http://www.summitpost.org/rocky-mountain-goat/404128>

Figure 14. Feral hogs. Retrieved from

<http://dallastrinitytrails.blogspot.com/2012/08/twilight-over-great-trinity-forest.html>

Figure 15. Big Horn Sheep of Colorado

http://www.coldwellbankerwestcliffe.com/photo_gallery_list.php

Figure 16. Long-Term World Oil Supply Scenarios. Retrieved from

http://www.eia.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html