

Earth Land Use

A Broad General Study
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Getting Started

- This began as a search to determine just how much of the earth's land surface was used for urban area
- It quickly blossomed into much more than this simple task
- I decided to document the information that I found

Characteristics of the Earth

- Surface of the Earth is water 70.8% (361.132 million km²) and land 29.2% (148.94 million km²)
- Land use of the 29.2% of the land surface:
 - Arable Land 10.6% (Annual Crops 4.71%)
 - Permanent Pastures 26%
 - Forests and Woodlands 32%
 - Urban Areas 2.4%
 - Other 29%

Majority of above data based on CIA World Factbook

Definitions are Important

- Most of the values noted on the previous slide are generally open for discussion
- Though there has been much effort to tightly define terms, dividing lines do begin to blur some and the percentage of land encompassing these land types may vary some
- Certain caveats must be carefully stated when using these values

Land Use Arable Land

- Arable land is generally defined as land that can be used for growing crops
- In this presentation, land found in pastures and forests that might be consider arable is excluded for detailed comparison
- A figure of 13% for total global arable land is based on readily converting certain “non-arable” land to crop land (which includes some arable forest land)

Arable Land Continued

- This larger value is better defined as “potential arable land” (some believe the true potential is about 26%)
- Most experts use a definition of arable land that is based on existing useable arable land and indicates that it is 10.6% of global land
- China has about 10% of the earth's arable land

Arable Land Continued

- Annual crop land use (includes crops not replanted each year or 1% of global land) is 4.7 % of the global land surface or almost 50% of global arable land
- Total annual crops on average cover about 7 million km² of the globe (2.77 million km² of which is irrigated)
- By definition, none of the crops noted above include timber or pasture products

Willis Eschenbach's Crop Research Slide

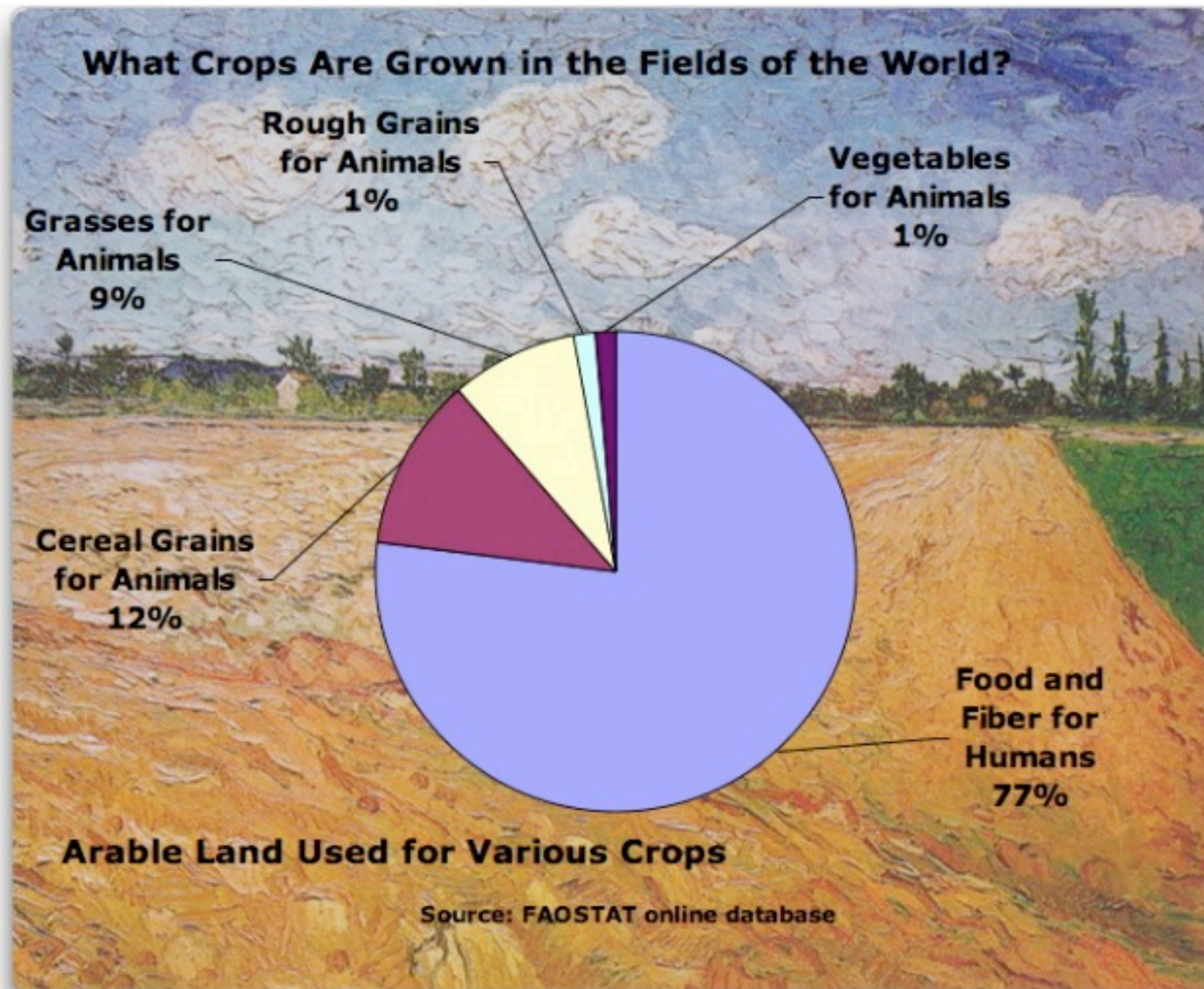


Figure 2. Area of arable land used for human crops, and for animal crops. Image is Van Gogh, "Ploughed Fields".

Potential Arable Land

- Economic and environmental issues generally drive the potential for expanding arable land resources
- Water and soil nutrients tend to be the limiting factors for meeting arable land requirements
- The Israelis have turned desert land into arable land

Potential Arable Land Continued

- Many of the world's pastures and steppes have the potential to be arable land (temperatures will limit alpine land's productivity)
- Generally for pastures the limits to "arable" land are also water and/or nutrients
- Forest land, even though some of it (besides the natural growth) is presently arable, is by definition not included in the arable land category

Land Use - Pastures

- Permanent pastures cover 26% of the globe's land surface
- A permanent pasture is an established plant community in which the dominant species are perennial grasses, there are few or no shrubs and trees are absent
- These pastures may blur the boundaries of some natural grasslands (alpine meadows, Mongolian steppes, etc)

Pastures Continued

- Pasture land is not defined as arable land even though much of it is - some part of the “semi-arable” pastures, grasslands, and steppes of the world could, with effort and financial resources, be made “arable”

Forests & Woodlands

- Forests and Woodlands cover 32% of the global land area (47.66 million km²)
- About half of these forests are located in Russia which have very slow growth rates due the extreme cold (mostly in Siberia)
- Northern hemisphere countries have “expanding” forests in recent decades
- Southern hemisphere countries have “diminishing” forests (often in the extreme) in recent decades

U.S. Forests - A few facts

- After continuous declines in forest area until the 1920s, US forests have stabilized and then gradually expanded in area until they are now more than 70% of the original forest (that existed in the early 1600s)
- Since the 1920s eastern forests have staged a major comeback
- Presently of the more than one billion acres in crop and forest land, forests today total 737 million ac. - in the 1600s forests alone covered a little over one billion ac.

U.S. Forests Continued

- Forest wildlife has increase in some cases 10 fold since the early 1900s. Wild turkeys were almost extinct and now number almost 5 million. Prong horns too were close to extinction but are now in the 100s of millions
- Government forest ownership is 28%
(of that National Forests are 18%)
Forest Industry is 15%
Other private ownership is 57%

“Other” Land

- Other land by most accounts make up about 30% of the rest of global land area -the value of “Other” land (29% of global land surface (43.25 million km²) is used in this presentation so that all the categories total to 100%)
- “Other” land covers a wide variety of land
- This includes deserts (which make up more than half of “Other” land), permanent ice, tundra, wild grasslands, steppes, mountains, rocky coasts, salty, polluted, coral atolls, etc

Urban Land Use

- Until recently most studies have used 1.5% of global land as urban (CIA included)
- The definition of urban seems to wander between the use of population density (preferred), light pixels at night, and/or surface disruption characterizations
- With the advent of more detailed satellite image analysis new values of land use seem to favor a higher value of perhaps 3%

Urban Land Continued

- Some reliable sources claim that 3% has been fudged too high and that 2.4% is probably closer to the correct number
- $2.4\% = 3.575$ million km^2
- There is some controversy on this point but I expect to see more effort and greater accuracy of this value in the next few years
- In 2010 about half the world's population lived in urban areas (3.5 billion) while about 3.4 billion lived in rural areas

Urban Land Continued

- I found a study that estimated that roads and parking lots covered between 1.5 to 2% of the world's land surface
- I am assuming that a significant portion of roads and parking lots are already included in the 2.4% value of urban land use

The ultimate land use question

What population can the earth support?

- A book and a paper written in 1967 by Colin Clark titled “Population Growth and Land Use” documented a very detailed study of this subject
- These documents are sometimes criticized because of their use of extreme scenarios
- Clark however, did, at least, delve deeply into the methodology and the available data

Max Population?

- He was criticized for grading land by its location and he graded tropical land as twice as productive as land in most other parts of the earth
- However, this technique is now widely accepted
- Clark reached his ultimate conclusions based on the use of most of the earth's land surface (61.5%) to grow food and fiber
- A more ecologically sound method that might actually be pursued would be to double global arable land to 21% in a carefully planned process
- Clark's carrying capacity values would then be 1/3 of the values that were given in his original research

Max Population?

- Clark proposed no miracle scenarios to save us
- Land, water, and food issues were covered in great detail
- Food and fiber in the final analysis became the limiting factor
- Energy issues were considered resolvable (negotiable or to be solved by a few technological breakthroughs)

Max Population?

- Using the so called “Dutch” diet (European or scaled down American) - capacity is 28 billion people (realistically 9.3 billion)
- Using the “Asian” diet - capacity is 47.6 billion (realistically 15.85 billion)
- With a subsistence diet with most of the population on the brink of starvation the capacity is 157 billion (realistically 52.3 billion)
- Today there is a global mix of these 3 diets with a large majority of the planet’s diet found in the 2nd and 3rd categories

Actual Expected Population

- To Peak at about 10 billion later in this century



Closing Thoughts

- Land use questions grew out of climate issues and questions about where surface temperatures were being measured (mostly in urban areas?)
- Earth carrying capacity studies are always very controversial
- Also there were questions about how badly we have “trampled” the land environment

More Closing Thoughts

- And just generally “how bad is it?”
- A surprise - not really that bad on the ground except, perhaps, in some densely populated urban areas
- And in some very poor countries
- Some specific air, soil, & water quality issues are also ongoing in some parts of the globe

Environmental Issues

- Poor and deteriorating soil conditions have natural and man-made reasons behind them
- The U.S. has made vast improvements in air and water quality over the past 50 years
- But some water use issues continue to plague us - mostly due to cyclical droughts (near term global cooling may alleviate this)

Finally

- As always my study leads to further questions and studies
- One in particular - why are NH forests expanding and SH forests (especially in Australia) shrinking?
- Will increasing CO² concentrations help “solve” some of our food subsistence issues?
- Does surface temperature measurement (especially if it is mostly done in cities) tell us much about global climate?