Comment on Guishen *et al.*[1]

Guishen *et al.*[1] demonstrate that Beijing City, which has a population of 27 million, has an ecological deficit equivalent to >24 Mha. Using the concept of global hectares (gha) as the area needed to support each hectare, they show that China is more sustainable than the rest of the world, as each hectare uses 1.74 ha of global resource, compared with an estimate for the world of 2.51 ha.

These estimates include fuel and other forms of energy consumption, as well as food. But they also estimate that cropland in China is only 70 % as productive as the global average i.e. surprisingly also 1.74/2.51. The world value implies that its Ecological Footprint (EF) is excessive (Table).

In 2013, the global EF was 20,827 Mgha compared with a total world biocapacity of 12,208M gha. This represents an overshoot of 8,618M gha[1], which is 1.71 times its biocapacity. Guishen *et al.*[1] indicate **our planet is unsustainable under our present system of using finite resources** and that we need additional land area which has the biocapacity of 0.7 times the world's present gha to meet our current demands, i.e.:

$1.15(7.5 \times 10^9)^* = y(12.2089 \times 10^9)$ and y = 8.625/12.2089 = 0.7065..... .....(1)

Both the ecological footprint and deficit values of the United States of America (USA) in 2013 were higher than were the equivalent values for China (Table). Although this could indicate that the USA is less sustainable than China, the ecological pressures and environmental impacts on farmland in China are more serious than in the USA. Per hectare China uses 2-3 times the world averages of fertilizer, pesticide and irrigation and also employs multi-cropping with a comparatively low use efficiency of inputs.

Nevertheless, the EF of the USA is 2.4 times that of China, owing to a higher consumption of products per capita, higher land productivity, less local small scale production and greater global trade. This implies that the developed regions (or nations) have appropriated more than their fair share of Earth's carrying capacity -a point frequently made by others. In this sense, using EF to define sustainability involves not only the specific footprint, but also global trade (reference to this in our companion editorial).

Generally during the last half century in most parts of the world, there has been a transition from a self-supporting local, to a more intensive modern industry based on non-renewable resource consumption. Theoretically therefore, reduced use of non-renewable resources is the pivotal measure to promote the sustainability of agro-ecosystems. Thus, there is an urgent need to reduce the sustainability gap of the home region or nation by reducing external inputs, but also increasing output per unit area.

One of the major agricultural inputs has been chemical fertilizers. Artificial fertilizers are mainly composed of nitrogen, phosphorus and potassium (NPK). Human food requirements are such that *adequate* production of staple crops would be impossible without these inputs. China has used them excessively- per hectare at 2-3-fold the world average[1]. The excessive use of N-fertilizers leads to pollution of water courses with nitrates and the atmosphere with nitrogen dioxide, a potent greenhouse gas.

But half the world's food production is dependent on the fixation of atmospheric N by the Haber-Bosch process[3] which currently uses a significant proportion of the world's electrical and gas energy. It seems to be absolutely essential that N-fertilizers are used with much greater precision than hitherto and that more renewable energy sources rather than fossil fuels are used to produce the electricity to mitigate undesirable impacts on climate.

Nevertheless, N is part of a cycle, so the supply is continuous. Deposits of Potassium (K) and Phosphorus (P) are still available in various regions but the *known* available sources of P are likely to become exhausted in the next 50 years[4].

As most waste P pollutes rivers and is eventually deposited on the ocean floor, or is used by marine life, this may become a limiting factor for human life, unless P can be cycled effectively.

In conclusion, a sustainable Earth for long term exploitation by humans can only be achieved by ensuring that our Ecological Footprint does not exceed the Earth's Biocapacity - this means we must, in the end, seek to use only renewable resources in all of Man's areas of activity.

References

1. Gregory, Professor, Peter, Susan Azam-Ali and Sayed Azam-Ali (2017) Crop Diversity for Human Nutrition and Health Benefits. **World Agriculture** #1720
2. Zhao Guishen,Liang Long and Li Li (2017) Methods for Increasing Sustainability of Agro-ecosystems Based on the Ecological Footprint in China **World Agriculture** #1719
3. Vaclav Smil (2012) Nitrogen cycle and world food production. **World Agriculture** #1203.
4. Peter S. Cornish (2013) Peak phosphorus: implications for agriculture. **World Agriculture** #1314

Figures

Table. *Estimated ecological deficits per capita caused by Man's use of finite resources (data taken from paper 1718[1])*

Land area, Year	Biocapacity	Ecological Footprint, EF	Ecological Deficit
Beijing City, 2011	0.032	>0.92	0.89
China, 2013	0.93	3.59	2.66
USA, 2013	3.78	8.59	4.81
World* 2013	1.63	2.78	1.15

*We have assumed a World population of 7.5×10^9

Figure 1.

Table 1

1718

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Comments

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