Sustainable Animal Agriculture in 21st century

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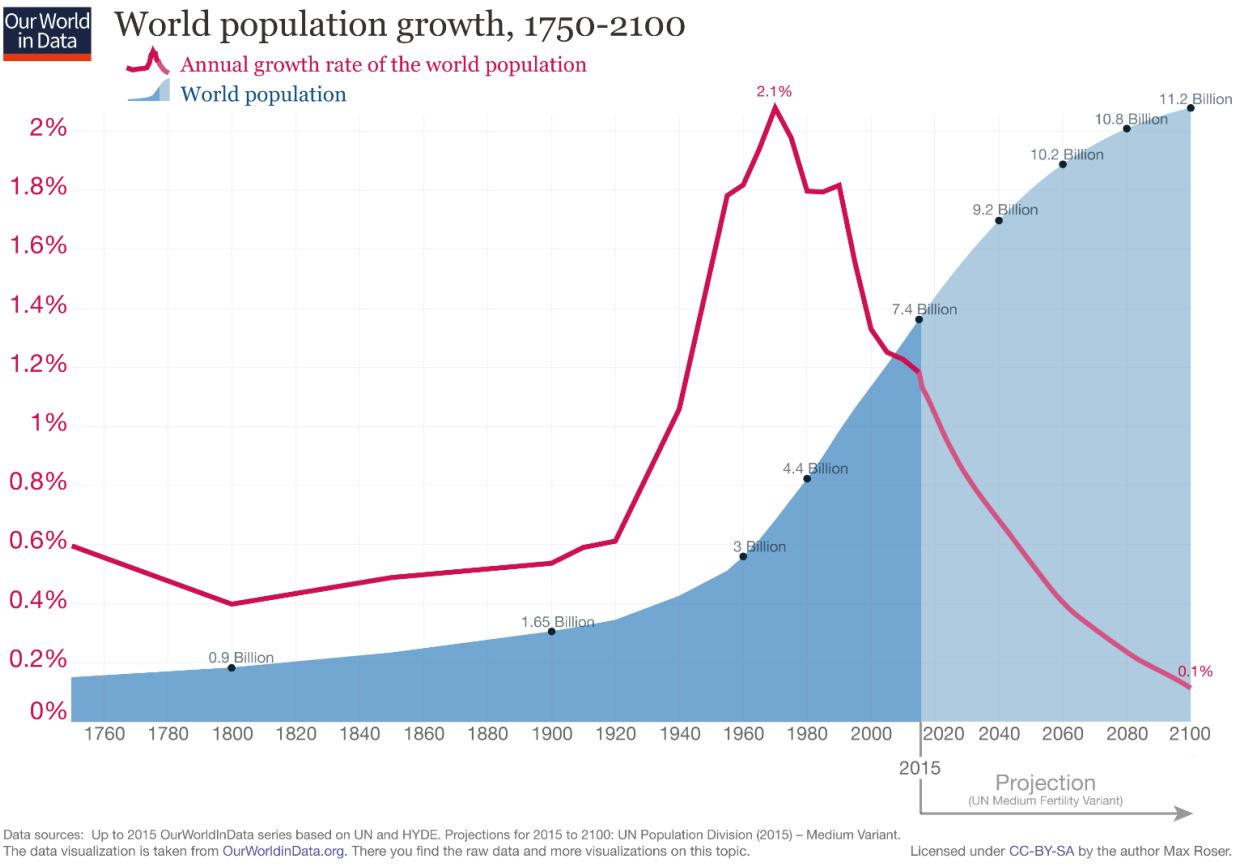
Introduction

Although the human population of the earth has been growing since the end of the Bubonic Plague of 1348, it has grown most rapidly since the end of the second world war. Coupled with decreasing mortality rates this has resulted in explosive population growth (Figure 1). However, as also noted in this figure the actual rate of population growth peaked in the late 1960's and has declined rapidly since. Ultimately, this will lead to a leveling of the world population at around 11.2 billion people in 2100. In addition to a rising population many consumers around the world are opting to increase the high-quality protein content of their diet (meat, milk and eggs). Structural changes in diets, will continue to determine shifts from staples to livestock products and fruit and vegetables. Thus, use of livestock products in human diets will increase in Asia, Latin America and Africa. According to estimates compiled by the Food and Agriculture Organization (FAO), by 2050 we will need to produce 60 per cent more food for a world population of 9.3 billion. Increasingly, public concerns around agricultural production practices and the "sustainability of our food production systems" have become part of the demands on our agricultural systems. Thus, in addition to increasing our food supply by 60 per cent our agricultural production systems are challenged to do so with less arable land, during a period of world-wide climate change with improved animal welfare practices and in a more sustainable manner.



In the last 50 years, there has been a remarkable emergence of innovations and technological advances that are generating promising changes and opportunities for sustainable agriculture, yet at the same time the agricultural sector worldwide faces numerous daunting challenges. Not only is the agricultural sector expected to produce adequate food, fiber, and feed, and contribute to biofuels to meet the needs of a rising global population, it is expected to do so under increasingly scarce natural resources and climate change. Growing awareness of the unintended impacts associated with some agricultural production practices has led to heightened societal expectations for improved environmental, community, labor, and animal welfare standards in agriculture.

What is Sustainable Agriculture?

The word sustainability must include a component that considers social values (Thompson, 1997, 2007). The current US legal definition (US Code Title 7, Section 3103) states : “an integrated system of plant and animal production practices having a site-specific application that will over the long-term: satisfy human food and fiber needs, enhance environmental quality and the natural resource base upon which the agriculture economy depends, make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls, sustain the economic viability of farm

operations, and enhance the quality of life for farmers and society as a whole." von Keyerslinkg et al. 2013.

The three pillars of sustainability are shown in Figure 2 and include environment, economic and social components. All three components must be addressed to provide sustainability to an agricultural enterprise.

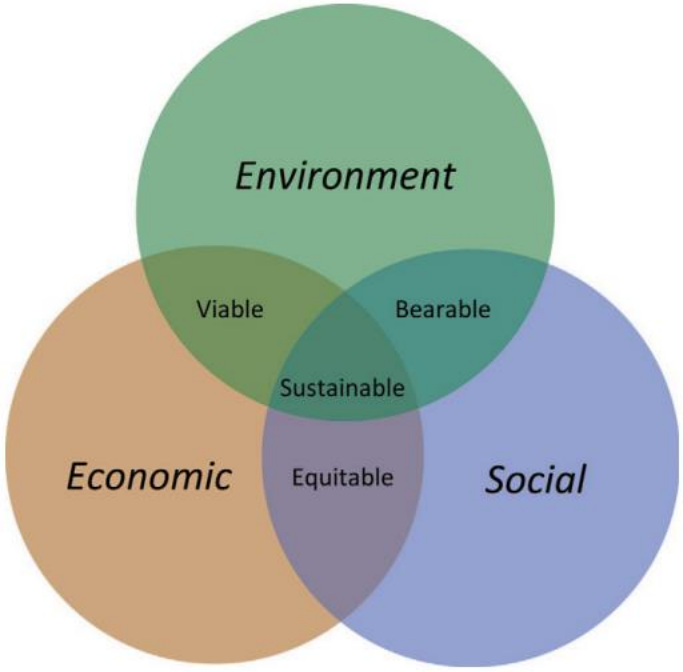


Figure 2. The three pillars of sustainability from von Keyserlingk et al. 2013

Since the 1940's the majority of research in agriculture has focused on increasing agricultural productivity. This has resulted in dramatic improvements in yield and efficiency of agricultural food production as shown in Figure 2.

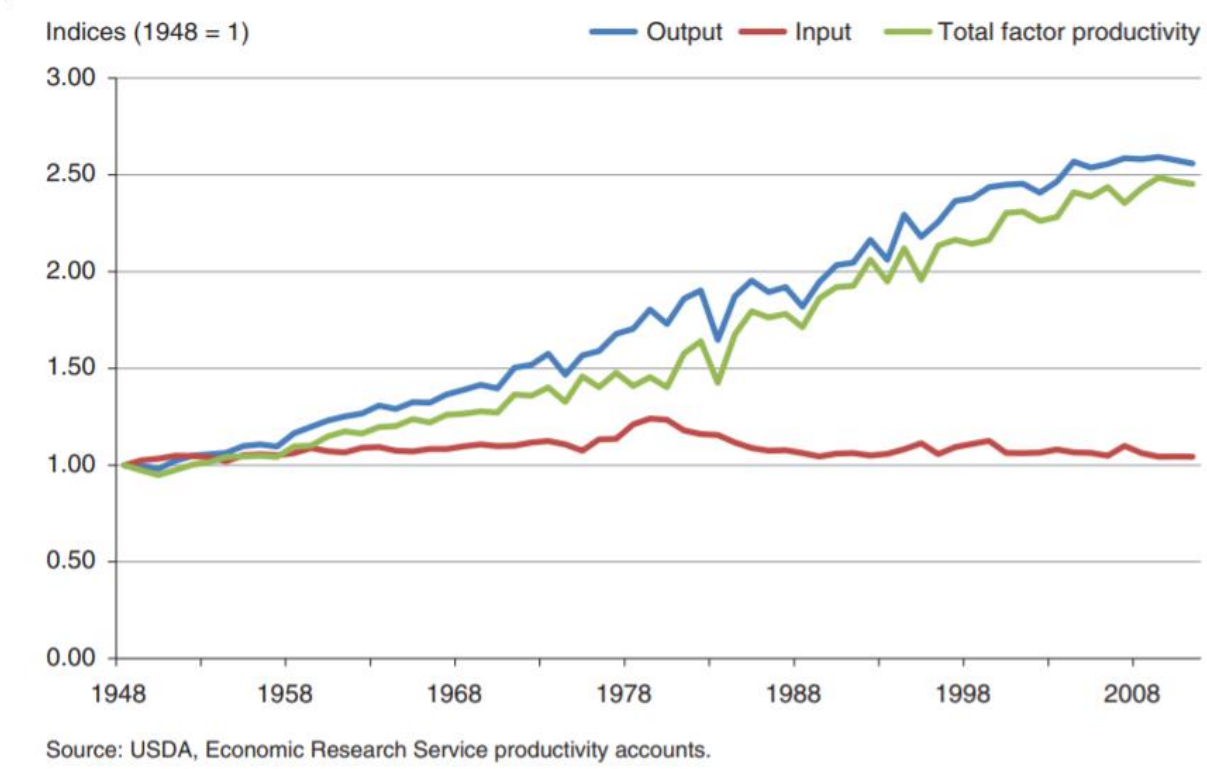


Figure 3. Agricultural productivity growth accounted for most output growth between 1948 and 2011

This figure represents all of agriculture and the animal agriculture components are included in the data used for the figure. Thus, improving agricultural productivity has contributed to historically low food prices in the U.S. since the end of the Second World War. It has also contributed greatly to the reduction in carbon footprint of animal agriculture.

However, this measure of agricultural efficiency does not encompass all of the components of agricultural sustainability. As pointed out by von Keyserlingk et al. in their review on sustainability "This approach alone will not address the gaps in knowledge and educational needs … for many aspects of the sustainability of dairy production and consumer understanding. We also require transformative research that allows for whole system redesign (Reganold et al., 2011). " These additional concerns include animal welfare, use of immigrant workers, carbon footprint, consumer input and economics.

In addition to the challenges of developing a holistic sustainable model for agriculture the animal agricultural sector faces the additional challenge of alternative protein sources to animal products as a disruptive force in the economics of animal agriculture. Alternative dairy, was analyzed by the consulting group of Ernst and Young, 2021 who provided a very bullish estimate of upwards of 60% market share by 2040, and they stated that this is a strong analog for alternative meat. The alternative meat forecast of 9% by 2030 compares favorably with the experience of alternative milk, which has penetrated American households and now accounts for 15% of all dollar sales of retail milk. Ernst and Young 2021. They further state that the additional components of the alternative dairy category, including cheese, is advancing

technologically and continues to attract increasing levels of investment. If social, environmental and regulatory drivers (e.g., water or carbon taxes) are factored into conventional protein production, market shares for alternative meat and dairy could surpass their base forecast considerably. Ernst and Young, 2021. However, the Purdue Center of Commercial Agriculture recently reported that the majority of 400 producers (86%) surveyed expected the alternative protein market share would be only 1-10 per cent in 5 years.

This emerging shift could explain why even though aggregate consumption of meat-based proteins worldwide is increasing, the overall growth rate is expected to decline by half. Plant-based food (the largest source of alternative protein) sales rose 17 percent in 2018 and the use of alternative protein as a food ingredient in consumer products is predicted to continue growing. Currently, the market base for alternative protein is approximately $2.2 billion compared with a global meat market of approximately $1.7 trillion, making the growth rate of the alternative proteins marginal to the overall meat market.

The best way for animal agriculture to respond to all of these challenges is to improve overall sustainability of animal agriculture which will counter many of the public perception issues around animal welfare and environmental impacts of animal products and keep animal products price competitive. If the dairy industry meets its target of zero carbon footprint of the dairy industry by 2050 it is difficult to imagine that alternative protein production could match that performance. This research effort to improve sustainability of animal agriculture has to be a multidisciplinary approach to include both agronomic and animal agriculture components to increase sustainability. Examples of these will be provided during the presentation.

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