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An Agro-Based Society after Post-Industrial Society: From a Perspective of Economic Growth Paradigm

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Abstract: Since the Industrial Revolution, a new era has arisen called the Anthropocene, in which human actions have become the main driver of global environmental change outside the stable environmental state of the Holocene. During the Holocene, environmental change occurred naturally, and the Earth's regulatory capacity maintained the conditions that enabled human development. Resource overexploitation of the industrial "Anthropocene", under the principle of profit maximization, has led to planetary ecological crises, such as overloaded carbon sinks and climate changes, vanishing species, degraded ecosystems, and insufficient natural resources. Agro-based society, in which almost all demands of humans can be supported by agriculture, is characterized by life production. The substitution of Agro-based society for a post-industrial society is an evolutionary result of social movement, it is an internal requirement of a sustainable society for breaking through the resource constraint of economic growth. The core feature of agriculture is to use organisms as production objects and rely on life processes to achieve production goals. The substitution of Agro-based society for a post-industrial society is the precondition for a sustainable carbon cycle, breaking through the resource limits of the industrial "Anthropocene", alleviating the environmental pressure of economic development, and promoting society from increasing disorderly entropy to orderly decreasing entropy. Meanwhile, technological advancements and growing environmental awareness of society make it feasible for the substitution of an agro-based society for a post-industrial society.

Keywords: agro-based society; industrial "Anthropocene"; economic growth paradigm

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1. Introduction

In 2008, the New Economics Foundation proposed "a paradigm shift from the general and unlimited pursuit of economic growth to a concept of "right-sizing", as a clear-sighted and inspiring vision of the 2008's Green New Deal (Barbier 2009), which suggested that the creation of economic prosperity was not senselessly decoupled from environmental issues (Mauerhofer 2019; Spash 2012). It has been proven that production with only a minor environmental impact seems technically and economically feasible in most cases (Martinez-Alier and Naredo 1982); furthermore, techno-optimists have proposed a transition to renewables as complementary paths out of the crisis to minimize the environmental impact of growth by overlooking the possibility of climate change and other problems of cost and implementation (Jonsson 2015). No matter the pro-growth-man or anti-growth-man (Solow 1973), "we have lived with a deep-seated belief that life will get better, that one should hope for abundance, and work toward obtaining it" (Rolston 2017, p. 51).

Despite the previous work noted above, behind this obvious but difficult question lies an even thornier one: what exactly is the alternative to economic growth? The objective of this paper aims to answer the question if and how a process of economic growth can materialize from within a new agro-based society with the help of bio-based technologies. So far, these sociological insights and ideas have been remarkably absent from the scientific discussion about the agro-based society after the post-industrial society through the abandonment of capitalism and the establishment of a sustainable economy. This paper consists of four parts. After a brief introduction, the resource limits of the affluent industrial "Anthropocene" are discussed in Section 1, which provides the theoretical backbone for the claims made in this article; Section 2 outlines the logical basis for the substitution of an agro-based society for an industrial society; Sections 3 and 4 outline the necessity and feasibility of the substitution of an agro-based society for an industrial society, respectively. We believe that it is unlikely that material use will be reduced if the economy grows within the classical paradigm of capitalism, a shift in the growth paradigm is required to ensure the feasibility of a social transformation.

2. Resource Constraint over Economic Growth of Affluent Industrial "Anthropocene"

2.1. Harmonious Agricultural Holocene with Prosperous Human Civilizations

More than two million years ago, humans began to emerge in many parts of the world. In the Olduvai Gorge in Tanzania, archaeologists discovered stone tools, animal remains, and sites where shacks might have been built. It is believed to be the earliest activity of ancestors as we know. At this stage of a hunter-gathering society, human beings primarily depended on hunting, fishing, and picking for their livelihoods, this stage was the "original affluent society" because all human material desired at this moment could be "easily satisfied" (Stirling and Sahlins 1975). "Before the advent of agriculture about 10,000–12,000 years ago, humans lived in small groups as hunter-gatherers" (Steffen et al. 2007, p. 614). In fact, a hunter-gathering society is closely related to poverty rather than abundance because nature's native feeding capacity is quite limited. The human hunting-gathering income is not only limited in species but also unguaranteed in quantity. On most of the days, the old ancestors were fighting to obtain enough energy to sustain their lives.

Ancestors all over the world began to enter into the primitive agricultural society after a long period of collection, fishing, and hunting as human beings became familiar with the habits of some animals and plants and then began to domesticate and breed animals and plants (Diamond 2016). Broadly defined as the cultivation and breeding of animals and crops, "agriculture appears to have originated at least 15,000 years ago, with the domestication of pigs in Mesopotamia where rice was cultivated by humans in China as far back as 13,500 years ago; sorghum was domesticated in Africa 7000 years ago, and maize was grown 6000 years ago in Mesonamerica. Food surpluses were a result of farming domesticated species, and this empowered the development of human civilization" (Rhodes 2017, p. 82). The concomitant domestication of plants during the early to mid-Holocene led to agriculture(Steffen et al. 2007). The planet's environment has been unusually stable for the past 10,000 years (Rockström et al. 2009), this stable period is known as the Holocene in which prosperous human civilizations arise, develop, and thrive. Without pressure from humans, the Holocene is expected to continue for at least several thousand years (Berger and Loutre 2002).

Agricultural development fundamentally changed human society and greatly accelerated the pace of social evolution, however, its spread throughout the world is still slow. The development of an agricultural society is a landmark moment in human history as human beings evolved from food collectors to food producers. Without agriculture, there would be no human civilization (Claessen and Skalník 1978). Meanwhile, it was a fallacy that preagricultural humans lived in idyllic harmony with their environment. A rather different picture has indicated the wide-spread human impact on the environment through predation and the modification of landscapes (Pyne 1997). There is no doubt that the domestication of animals exerted a profound impact on fauna (Leach 2003). Early agricultural development around the mid Holocene fundamentally affected the functioning of the Earth System (Ruddiman 2003); the clearing of forests for agriculture about 8000 years ago and the irrigation of rice about 5000 years ago led to increases in atmospheric carbon dioxide (CO_2) and methane (CH_4) concentrations (Lambin and Geist 2006). It is undoubted that "the human imprint on environment may have been discernible at local, regional, and even continental scales, but preindustrial humans did not have the technological or organizational capability to match or dominate the great forces of nature." It is believed that the advent of agriculture remains an intriguing but unproven beginning of the "Anthropocene" (Steffen et al. 2007, p. 614).

2.2. Environmental Crises and Resource Overexploitation Arising from Industrial "Anthropocene"

The entry of mankind into an industrial society is a great leap in human history. Since the Industrial Revolution, a new era has arisen as the "Anthropocene" (Rockström et al. 2009), in which human actions have become the main driver of global environmental change outside the stable environmental state of the Holocene. Although both its scientific legitimacy and broader social meaning are still infant, the concept of the "Anthropocene" has attracted public and scholarly recognition recently (Jonsson 2015); the "Anthropocene" is a popular concept and an umbrella term for the understanding of environmental crises (Thornton and Thornton 2015).

The industrial revolution was first proposed in the monograph of *The Condition of the Working Class in England* as early as in 1845 by Engels; it was only widely accepted with the publishing of *The Lecture Collection of Industrial Revolution* of British Toynbee in 1884. It is a far-reaching economic transition from the agricultural economy, characterized by its low productivity and stagnant growth to the Industrial Revolution with developed productivity and continuous growth. In the pursuit of a harvest of wealth and prosperity, mankind's production modes were fundamentally changed by machine production and factory systems. With the coordination of systems and rules, machinery application pushed by fossil fuels released production capacity. This industrial capital paradigm of the "Great Transformation" swept the world like a whirlwind (Polanyi 1957).

As the first industrial society, Britain was the richest and most powerful country in the world. During the century of the 19th century, the production of raw coal in Britain increased by 20 times, the production of pig iron increased by 30 times, and the import of raw cotton increased by 30 times (Briggs 1987). With the increase in productivity, a huge amount of wealth was created associated with earth-shaking changes in social politics, economies, culture, and technologies. After the Industrial Revolution, the types of products produced and consumed increased from less than 1000 to nearly 10 billion. According to the statistics in October 2017, there were 598 million products sold on Amazon.com alone (Zhang 2018). In less than three centuries, the industrial society has achieved great success; at the same time, it is also facing severe crises, such as resource shortages, environment degradation, and unsustainable development.

3. The Logical Basis for the Substitution of Agro-Based Society for Industrial Society

3.1. The Result of Social Movement under the Law of Negation of Negation

Schrödinger (1944) pointed out that a living organism not only need energy but also low entropy, which it sucks from the environment and degrades into high entropy (waste). This continuous flow of low entropy maintains the biological body in good order and also supports all activities of the organism. During the Holocene, environmental change occurred naturally, and the Earth's regulatory capacity maintained the conditions that enabled human development. In addition to the Industrial Revolution, largely because of a rapidly growing reliance on fossil fuels and industrialized forms of agriculture, human activities have reached a level that could damage the systems that keep the Earth in the desirable Holocene state. The result could be irreversible and, in some cases, abrupt environmental change, leading to a state less conducive to human development (Steffen et al. 2011).

In view of the unsustainability of the industrial society, people are actively exploring future social forms. Kant took the law of negation of negation as a form of constructing the transcendental category structure, thus creatively introducing it into the field of thinking. Kant (1980) believes that the self-unification of negation is the basis of all these provisions. However, here, the first negation, that is, the general negation, of course, must be distinguished from the second negation, that is, the negation of the negation; the latter is the specific absolute negativity, while the former is only abstract negativity. Hegel fully agrees with Kant's thinking and believes that the negation of the negation is developed in three stages, they are the topic, the anti-theme, and the combined topic. The instinct of the great (dialectics) concept makes Kant say: the first category is yes, the second category is the negation of the first category, and the third category is the synthesis of the first two.

The core feature of agriculture is to use organisms as production objects and rely on life processes to achieve production goals. In an agro-based society, social production is dominated with modern agriculture, and the living materials needed by human beings are all or mainly based on the social form provided by agricultural products (Han and Xia 2018). An agro-based society inherits the advantages of an agricultural society and an industrial society; it is not the simple sublimation of their contents. In this process, subversive changes have taken place in production methods, and human needs can be fully satisfied by agriculture with breakthrough advancement over technologies and productivities. In particular, the development of life science and biotechnology employed by modern agriculture has far exceeded the imagination of traditional farmers. In the future, the products produced by agriculture may satisfy most or even all diversified humanity demand. With the big achievement of technologies, "over the past several decades' rapid advances in transport, energy, agriculture, and other sectors have led to a trend of dematerialization in several advanced economies. The amount and value of economic activity continue to grow but the amount of physical material flowing through the economy does not" (Steffen et al. 2007, p. 619).

The significance of the Entropy Law in understanding the economic process has long been maintained by Georgescu-Roegen (1971, 1975). Economic processes are nonreversible. The economic process with biological systems that are entropy-reducing contribute together with their environment to the inevitable rise in the entropy of the universe (English 1975). The entropy argument was fundamentally flawed, and the limits to growth have not gone without a challenge (Young 1983). "Sooner or later, the productivity of oil will rise out of sight, because the production and consumption of oil will eventually dwindle toward zero, but real GNP will not. So there really is no reason why we should not think of the productivity of natural resources as increasing more or less exponentially over time" (Solow 1973, p. 45). There are further technological opportunities because worldwide energy use is equivalent to only 0.05% of the solar radiation reaching the continents (Haberl 2006). Technology must play a strong role in reducing the pressure on the Earth System.

3.2. The Internal Requirement for Breaking through Growth Limits of Industrial "Anthropocene"

The industrial society has created a miracle of economic growth, ignoring the erosion of the environment and resources in the industrial society. The industrial society has developed to this day, and its advantages in economic growth are being weakened. The "Anthropocene", proposed by Crutzen and Stoermer (2000), supposed that we are now living in a new geological epoch of the age of humans "at around AD 1800 or the beginning of the Industrial Revolution" (Knight and Messer 2012, p. 371). According to the second law of thermodynamics, a closed thermodynamic system is what exchanges no matter and no energy with its environment (Georgescu-Roegen 1976). Therefore, "matter is subject to irrevocable dissipation just as available energy is continuously transformed into unavailable energy" (Smith and Smith 1996, p. 310). Even a world with zero population growth and a steady state economy at current consumption levels is not sustainable in perpetuity (Georgescu-Roegen 1976) because resource exhaustion in a finite period is evitable because nonrenewable resources tend to irretrievably dissipate.

In recent years, the world economy is facing the threat of a new mediocre era that has maintained low growth for a long time. What Lakatos (1970) has called a research program, the paradigm of degrowth tries to expose the impossibility of exponential economic growth in a finite world and to outline alternative trajectories for social development as a rational cognition that the productive economy of industrial society is approaching the Earth's carrying limit. This is not a new idea, Malthus first proposed the limits to growth and was criticized primarily because of his simple mathematical laws of assumed population and resources grow. In his Essay on Population in 1798, Thomas Malthus drew a conclusion that geometric growth populations would grow faster than the food supply, which increases at an arithmetic rate, and would eventually be limited by famine, war, and pestilence. It was during the mid to late 1970s that the word décroissance, the French word for degrowth, was first mentioned in the work of Nicholas Georgescu-Roegen. He proposed that even a world with zero population growth and a steady state economy at current consumption levels was not sustainable in perpetuity because nonrenewable resources tended to irretrievably dissipate (Georgescu-Roegen 1975).

As the ability of the human beings to transform the planetary environment has reached an unprecedented scale and magnitude in the past few decades (Jonsson 2015), the development of an industrial civilization has approached its limits (Rockström 2009). This has pushed scholars to think about the "Anthropocene" age with scarce ecological space (McAfee 2016). Although it was not utilized as an activist slogan until after 2000 (Whitehead 2013), the financial and economic turmoil recently on top of the ever-present environmental problems has invigorated doubts about the deep-seated anthropocenic idea that prosperity depends on economic growth. Before the fundamental adjustment of the growth paradigm, the degrowth trend is inevitable (Garcia 2012). The ultimate aim of degrowth is the so-called 'steady state economy' (Daly 1991). The idea of degrowth sounds simple and means to halt or slow down economic growth in order to bring economies back within an ecological limit (Rockström et al. 2009).

Due to the radical consequences of cancelling out economic growth, degrowth raises questions about its practical feasibility (Foster and Magdoff 2010). Therefore, where should the society go? An agro-based society is an inevitable substitution for an industrial society. The industrial economy has come to the "tech plateau" where the air is thin, and the global economy has entered and will continue to be in an era of "Great Stagnation". An agro-based society is a breakthrough in the inability of the industrial society to sustain its own contradictions. This fundamental adjustment of social production methods will inevitably lead to a fundamental improvement in the growth paradigm. Under this background, various economic sectors and the economy will be reconstructed. Resources will usher in a reorganization so that the entire social economy will usher in new growth opportunities. Instead of mechanical forces to complete production tasks, agro-based production methods have four main characteristics: one is to use biological processes as much as possible; the second is to make full use of bioenergy instead of fossil energy; the third is to replace various minerals with biological materials; and the fourth is the production process, that is, the metabolic process. Waste can be decomposed in the second metabolism, which is an environmentally-friendly production method. Therefore, the substitution of an agro-based society for an industrial society provides a profound basis for the sustainable development of human economic society.

4. The Necessity of the Substitution of Agro-Based Society for the Post-Industrial Society

4.1. The Inherent Requirement for a Sustainable Carbon Cycle

Before the Industrial Revolution, the concentration of carbon dioxide in the atmosphere was about 275 ppm, and thereafter it increased year by year. The concentrations of CH_4 and nitrous oxide (N_2O) resulting from the global-scale industrial transformation had risen by 1950 to about 1250 and 288 ppbv, respectively, noticeably above their preindustrial values of about 850 and 272 ppbv (Blunier et al. 1993; Machida et al. 1995). By 1950, the atmospheric CO_2 concentration had pushed above 300 ppmv, above its preindustrial value of 270–275 ppmv (Etheridge et al. 1996). This coincided with the beginning of the industrial era in the 1800–1850 period when "nearly three-quarters of the anthropogenically driven rise in CO_2 concentration has occurred since 1950 (from about 310 to 380 ppm), and about half of the total rise (48 ppm) has occurred in just the last 30 years" (Steffen et al. 2007, p. 618).

By the 1950s, it had reached 315 ppm; in April 2014, it exceeded 400 ppm for the first time, and it exceeded 410 ppm in April 2017. The average concentration reached 414.7 ppm in May 2019, which was an unprecedented high level in human history and the highest in millions of years. With the exception of a few scientists, mankind as a whole does not pay enough attention to this issue. The latest *Intergovernmental Panel on Climate Change* assessment report described the public's response as "business-as-usual", which is the worst case. If we continue "business-as-usual", this amount will reach 1370 ppm in 2100 and 2000 ppm in 2250. The continuous increase in carbon dioxide concentrations will cause environmental disasters, and a series of catastrophes caused by global warming will directly endanger the survival of mankind.

The main source of carbon emissions is fossil fuels extensively used by industrial society. Reducing the use of fossil fuels is the most effective measure to reduce carbon emissions, and the biological capture of carbon dioxide in the air is the most feasible measure for carbon neutrality. Life on Earth is carbon-based, and the agricultural-based production process is the natural carbon cycle process. Organisms combine CO_2 and water to form hydrocarbons through photosynthesis. In this process, solar energy is stored in the chemical compounds. Substituting biomass for fossil fuels not only meets human energy needs, but also realizes the carbon cycle. In 2000, nearly 10 million tonnes of renewable liquid fuels were produced using biological methods in the world (Xing and Liu 2007). In 2018, the total global primary energy consumption was 13.865 billion tonnes of oil equivalent, and the newly produced biomass exceeded 170 billion tonnes each year, which was converted into 85 billion tonnes of standard coal or 60 billion tonnes of oil equivalent (Yan et al. 2009). Considering that, there is considerable room for unused technological advancement of biomass production, which in theory can fully meet human energy needs. In addition to biomass, biophotovoltaic and biohydrogen production will also be very useful in carbon sequestration.

4.2. The Inherent Requirement for Breaking through the Bottleneck of Resource Shortage

All biological and social economic activities depend on the availability of resources. "As is well known, Ricardo assumed land to be of differential quality and variable supply with diminishing returns proceeding more or less continuously at the intensive and the extensive margins simultaneously" (Young 1983, p. 82). More importantly, industrial society is built on the basis of massive consumption of resources. Since the Industrial Revolution, the consumption level of global resources, especially nonrenewable mineral resources, has risen sharply. "Industrial societies as a rule use four or five times as much energy as did agrarian ones, which in turn used three or four times as much as did hunting and gathering societies" (Steffen et al. 2007, p. 616). Compared with the infinite of human beings, the limited stock of mineral resources on the Earth can only be considered a drop in the bucket. From the perspective of static recoverable reserves, major global resources will be exhausted in a few decades without further technological breakthroughs.

"Closed systems exchange energy but no matter with their environment" (Smith and Smith 1996, p. 313). According to the Entropy Law, the degradation of the resource base, the transformation of useful matter and energy into unavailable matter and energy is a unidirectional and irrevocable process. "Therefore, entropy may be seen as the ultimate physical basis of scarcity. The inability to reuse matter and energy in conjunction with finite sources of matter and energy implies the existence of a physical barrier to maintain an economic system in a stationary state" (Young 1983, p. 85). In recent years, shortages of raw materials have occurred from time to time, even extremely abundant sands are in short supply. The United Nations Environment Programme issued a special issue of *Sand, Scarce Than You Think* in 2014. Unless we make fundamental changes to the existing production methods, the shortage of raw materials will become more and more serious. The production of an agro-based society is mainly realized through the life process. Therefore, as long as the environment where life is located has not undergone major catastrophes, production will be sustainable.

4.3. The Inherent Requirement for Alleviating the Environmental Pressure of Economic Development

Nature has attracted a huge amount of attention over the past four decades due to the worries over planetary ecological crises, such as overloaded carbon sinks and climate changes, vanishing species, degraded ecosystems, and insufficient natural resources (McAfee 2016). One of the hallmarks of productivity development is a significant increase in waste production. Solid waste management has emerged as a major challenge to environmental management all over the world, especially in the urban areas of developing countries (Al-Khatib et al. 2010; Jin et al. 2006; Zhang et al. 2010). According to statistics from the book of *Urban Domestic Waste-Past and Present*, a Parisian threw away an average of 200 grams of garbage every day in 1872. In 1922, the figure was 700 grams, and in 1994, it was as high as 1600 grams (Tang et al. 2012). Since Leo Hendrik Baekeland invented and successfully registered patents for phenolic plastics in 1907, the plastics industry began to develop rapidly. In 1950, two million tonnes of plastics were produced globally, and in 2015 this increased to 400 million tonnes. So far, humans have produced a total of more than nine billion tonnes of various plastics, of which more than seven billion tonnes have completely become waste. According to *The 2014 UNEP Yearbook and Valuing Plastic*, the damage posed by plastic waste materials on marine life is estimated to be USD 13 billion annually (UNEP Yearbook 2014). According to current trends, there will be approximately 12 billion tonnes of plastic waste in the world by 2050. It is estimated that by 2025, for every kilogram of marine fish in the ocean, there will be 330 grams of plastic in the area where it lives, and by 2050, the weight of plastic will exceed the weight of marine fish. The composition of electronic waste is complex. Lead in soldering joints and resistors, cadmium in semiconductors, mercury in printed circuit boards (PCBs), chromium in metal plating, nickel or lithium in batteries, and beryllium in motherboards, etc., are harmful to groundwater, soil, and air and cause serious pollution. The *2017 E-waste Report* issued by the International Telecommunication Union (ITU) pointed out that in 2016, a total of 44.7 million metric tonnes of e-waste was generated globally, and it will increase to 52.2 million metric tonnes in 2021 (Baldé et al. 2017).

An agro-based society also produces waste, but it is mainly the result of biological metabolism. The composition of these wastes is relatively simple, and basically they can be degraded in the natural environment and reused by other organisms. In addition, agricultural or biological methods have higher efficiency and more thorough effects in the treatment of existing environmental pollution, and wetlands are typical in this regard. Nowadays, the use of genetically recombined microorganisms to decompose some toxic industrial wastes and the use of biofilms to treat wastewater have achieved commercial success. In contrast, the use of physical and chemical methods to control pollution has not only limited treatment effects but also its own possibility of generating new sources of pollution.

4.4. The Approach for Promoting Society from Increasing Disorderly to Orderly Decreasing Entropy

"Perhaps no other law occupies a position in science as singular as that of the Entropy Law. It is the only natural law which recognizes that even the material universe is subject to an irreversible qualitative change, to an evolutionary process" (Georgescu-Roegen 1975, p. 352). According to Arthur Eddington, the law that entropy always increases—the second law of thermodynamics—holds, which has played an important role in justification for the idea that economies have limits to growth (Smith and Smith 1996). If entropy is an index of the amount of available energy relative to the absolute temperature of the corresponding isolated system (Georgescu-Roegen 1986), all of these considerations are closely tied in with the concepts of order/disorder, and of entropy. Surprisingly perhaps, even information content can be defined in terms of order/disorder and therefore of entropy (Lovejoy 1996).

According to Clausius, an isolated system can exchange neither energy nor matter with its outside environment. In 1850, German physicist Rudolph Clausius discovered that it is impossible to transfer heat from a low-temperature object to a high-temperature object without causing other changes. If this direction is reversed, it needs to consume energy or cause other changes. This is the famous second law of thermodynamics. On the basis of this theory, Clausius created the word entropy. Entropy is a basic parameter that characterizes the state of matter, and its physical meaning is a measure of the degree of chaos in a system. Within closed systems, entropy should be maximized and disorder should reign (Schrödinger 1944). When the entropy reaches its maximum value, the entire system reaches the most disorderly equilibrium.

The energy of the universe is constant. Therefore, the entropy of the universe tends to a maximum (Georgescu-Roegen 1986). For a closed system, its entropy must increase over time. If entropy is regarded as an index of the amount of unavailable energy in a given thermodynamic system at a given moment of its evolution, "the entropy of a closed system continuously increases toward a maximum", "life seems to evade the entropic degradation to which inert matter is subject" (Georgescu-Roegen 1975, pp. 351, 353). "The origin of life should not be seen as an isolated event. Rather, it represents the emergence of yet another class of processes whose goal is the dissipation of thermodynamic gradients" (Schneider and Kay 1994, p. 37). Living systems are characterized to increase access to energy sources, and/or increase the efficiency of currently employed energy transformation processes (Georgescu-Roegen 1971; Schneider and Kay 1994; Buensdorf 2000). In the spatially open systems, plants and forests are subject to two opposing gradients: the thermodynamic degradation gradient and the incoming solar radiation gradient. Solar radiation provides the energy necessary for these systems to oppose thermodynamic degradation. "Life is an emergent phenomena created by the constant influx of solar radiation which maintains living systems in a non-equilibrium state" (Raine et al. 2006, p. 357).

Since the Entropy Law is about energy, it can be extended to matter only by analogy, "negetropy can be imported as the earth imports energy from the sun" (Young 1991, p. 178). Agricultural production is also a process of entropy reduction. "Some organisms slow down the entropic degradation. Green plants store part of the solar radiation", "all other organisms, on the contrary, speed up the march of entropy. Man occupies the highest position on this scale, and this is all that environmental issues are about" (Georgescu-Roegen 1975, p. 353). In 1943, Schrödinger said in a speech, "all things in nature tend to change from order to disorder, that is, entropy increases. Life needs to constantly offset the positive entropy generated in its life to maintain itself at a stable and low level of entropy. Life is based on negative entropy." In the following year, Schrödinger elaborated his theory in "What is Life", which played a leading role in the development of modern biology marked by DNA. Scientists generally believe that life phenomena are highly ordered, and life reduces its internal entropy. Prigogine (1969) regards life form as a dissipative structure, an open system far from equilibrium, which can exchange matter and energy with the outside world, thereby making it possible to realize the original disorder to order. The process of state evolution can maintain this process by dissipating matter and energy.

Establishing a dissipative structure can effectively avoid entropy death. Without life, the Earth will still fall into an endless loop of entropy increase. Humans move more Earth and produce more reactive nitrogen than all other terrestrial processes combined (Galloway 2004). "The crux of the argument revolves around the treatment of material resources. This is because the entropy law as a physical principle applies only in a closed system and then only to energy. However, since the earth is an open system with respect to energy any inevitable entropic decay or dissipation in the earth which sets a long-run physical limit on economic activity must occur for matter, not for energy" (Young 1991, p. 169). On the Earth as an open system, agricultural activities can "exchange both energy and matter with the environment" (Smith and Smith 1996, p. 312). Agriculture plays an important role from the perspective of entropy reduction.

5. The Feasibility of Substitution of an Agro-Based Society for an Industrial Society

5.1. Technological Basis for the Substitution of Agro-Based Society for Industrial Society

Economic systems are highly evolved ecosystems that have harnessed a new substrate knowledge that enables them to extend their organized complexity and, correspondingly, their dissipative potential (Miller 1999; Potts 2003). In addition to the many opportunities for energy conservation, numerous technologies are available now or under development to replace fossil fuels (Rahmstorf et al. 2007). Although all thermodynamic laws, unlike most other natural laws, express an impossibility (Georgescu-Roegen 1986), the technosphere could supersede the biosphere in the future (Rolston 2017, p. 45). Proponents of the Entropy Law as a physical constraint on economic growth must show that it applies to matter as well as energy. Technological powers have been escalated a lot.

The advancement of science and technology has made the production methods and final products of modern agriculture greatly different from those of traditional agriculture. Since the 1950s, the scientific community has gradually deepened the research on cells and the genes that control the genetic characteristics of cells. Gene recombination and cell fusion technologies can more effectively allow organisms to produce substances needed by humans, thereby enabling agriculture and its products. There are more possibilities. New varieties and new technologies continue to emerge, new operating methods and new application areas are subverting traditional agriculture. New technologies have enabled modern agriculture to not only produce more and more types of food with more and more nutrients but also to meet human needs in all fields as much as possible. In the future, agriculture will provide most of the energy needed by the whole society, provide as many materials as possible for industrial production, and, at the same time, create a cleaner and sustainable environment for us.

New and different technologies are promoting the progress of agriculture, especially the life sciences and biotechnology. Bill Gates thought as early as 1996 that "biotechnology will change the world like computer software." With the help of biotechnology, farmers in the future will produce most of the items and raw materials needed by mankind in the field, such as rice, vegetables, fruit, meat, and even fuels, medicines, building materials, sensors, chips, etc. At present, all countries attach great importance to the development of biotechnology, and some developed countries and emerging economies have issued corresponding policies to make strategic arrangements for this. In 2012, the United States released the *National Bioeconomy Blueprint for the United States Supporting the Bioeconomy*. The European Union listed in *Innovation to Achieve Sustainable Growth: Bioeconomy in Europe* genetically modified crops, forestry, fisheries, biopharmaceuticals, and new molecular entities, biomarkers, and genetic testing as well as key areas such as biofuels, biochemicals, industrial enzymes for raw material production, biosensors, bioremediation, resource extraction, and biorefining; in 2014, the OECD determined the structure of the biological industry. The three main subindustries are biomedicine, bioagriculture, and bioindustry (Bai et al. 2020).

As a science of artifacts, "the capacity to produce has been augmented by the capacity for information transfer" (Rolston 2017, p. 50). The rapid development of biotechnology in recent years has attracted widespread attention from the whole society, and, at the same time, provides more possibilities for agriculture. there were 40 Nobel Prizes in Chemistry related to the life sciences in 1901–2001, accounting for more than one third (Ren et al. 2012). There were eight Nobel Prizes in Chemistry from 2002 to 2016 related to the life sciences, accounting for more than one half. The year 2018 was the year of biotechnology, and eight scientists were awarded three natural science prizes, four of which were related to the development of biotechnology. The new crown epidemic in 2020 has further provided a catalyst for the development of biotechnology. More and more people believe that the 21st century is the century of biotechnology, and the achievements of biotechnology are changing the state of agriculture and promoting social progress.

5.2. Environmental Basis for the Substitution of Agro-Based Society for Industrial Society

The idea of degrowth is to keep economic growth within ecological limits (Boonstra and Joose 2013). The postmaterialist value change is inadequate for explaining global environmentalism (Brechin and Kempton 1994; Dunlap and Mertig 1997). Although improved technology is essential for mitigating global change, it may not be enough on its own; changes in societal values and individual behavior will likely be necessary (Fischer et al. 2007). "Technology changes the future, but so do ideas. Ideas drive technology, and also drive the values that we choose to carry from past through the present, conserving or reforming them for the future. We are at a hinge point in our history, reevaluating how we value nature and human nature" (Rolston 2017, p. 42). "Whether we accept it or not, human beings now shoulder the responsibility of planetary management; once the planet was larger than us, but it no longer is" (Thompson 2009, p. 97). Celebrated in an *Ecomodernist Manifesto*, a dozen and a half international environmental leaders have advocated "an ecologically vibrant planet" (Asafu-Adjaye et al. 2015, p. 31). Surely this modern humanism will treasure ecosystem services. However, these ecomodernists anticipate what they call decoupling. By this account, we need to be increasingly high tech to save nature (Steffen et al. 2015).

Rockström (2009) argues that there are nine planetary systems on which humans depend. These can be seen by an analysis of chemical pollution, climate change, ocean acidification, stratospheric ozone depletion, biogeochemical nitrogen-phosphorus cycles, global freshwater use, changing land use, biodiversity loss, and atmospheric aerosol loading. Since the Industrial Revolution, in three of these systems the boundaries have already been exceeded: biodiversity loss, climate change, and the nitrogen cycle" (Rockström 2009; Rolston 2017, p. 47). By examining the "rational man" and "value-neutral measurement" theories of neoclassical economics from different perspectives, scholars have a new understanding of the anthropocentrism tendency and the paranoia of rational measurement, and they believe that the analysis of the "cost-benefit" should be given new variables in the development of economics in the future (Bryant 2008). The overall environmental factor cannot be ignored in the economic decision making of human beings to maximize the benefits. In 1987, Ye used the concept of ecological civilization for the first time. From the perspective of ecological philosophy, he pointed out that ecological civilization means that mankind benefits both nature and man. It protects nature while transforming nature and maintains a harmonious and unified relationship between man and nature (Ye 1987). With the frequent occurrence of environmental problems in the later stages of industrial society, the ecological awareness of the whole society has been significantly improved. To pursue a better and quality life, environmental ethics is promoted by a large number of people. "Ecological modernization theory posits that advanced industrial nations can foster environmental improvements and economic sustainability through adjustments in production and consumption habits" (Walker 2007, p. 294). "What we call 'saving the Earth' will, in practice, require creating and re-creating it again and again for as long as humans inhabit it" (Shellenberger and Nordhaus 2011, p. 61).

6. Conclusions

As humans have entered into "Anthropocene", the negative impact of humans on the environment has been unprecedented. Sustainable development has been proven to be the only way of human society without feasible paths. An agro-based society, in which almost all demands of humans can be supported by agriculture, will be an inevitable, necessary and feasible option of the society after industrial society. An agro-based society is a thorough abandonment of capitalism with a shift in growth mode based on a foundation of technology, and society will ensure the feasibility of social transformation. The substitution of an agro-based society for an industrial society is an evolutionary result of negation of negation as an internal requirement of sustainable society for breaking through resource limits of economic growth. Meanwhile, the substitution of an agro-based society for industrial society is the inherent requirement for a sustainable carbon cycle, a feasible alternative mode for breaking through the resource shortage of social development, for alleviating the environmental pressure of social development, and promoting society from increasing disorderly entropy to orderly decreasing entropy. Meanwhile, the substation is a feasible option because society has established the technological basis and social foundation of environmental awareness for an agricultural-based society to replace an industrial society.

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