Sustainable Development Goals (SDGs)

—*Synecoculture*—

Kousaku Ohta
Sony Computer Science Laboratories, Inc.

Masatoshi Funabashi
Sony Computer Science Laboratories, Inc.

1. Introduction

The UN Sustainable Development Goals aim to address a wide range of issues. Wall et al.[1], in particular, stressed the need to pursue a concerted effort in addressing soil-related issues, specifically in regard to Goals 1, 2, 3, 6, 8, 11, 13, 14, and 15. Agriculture is an area that is deeply related to all these goals.

2. Agriculture

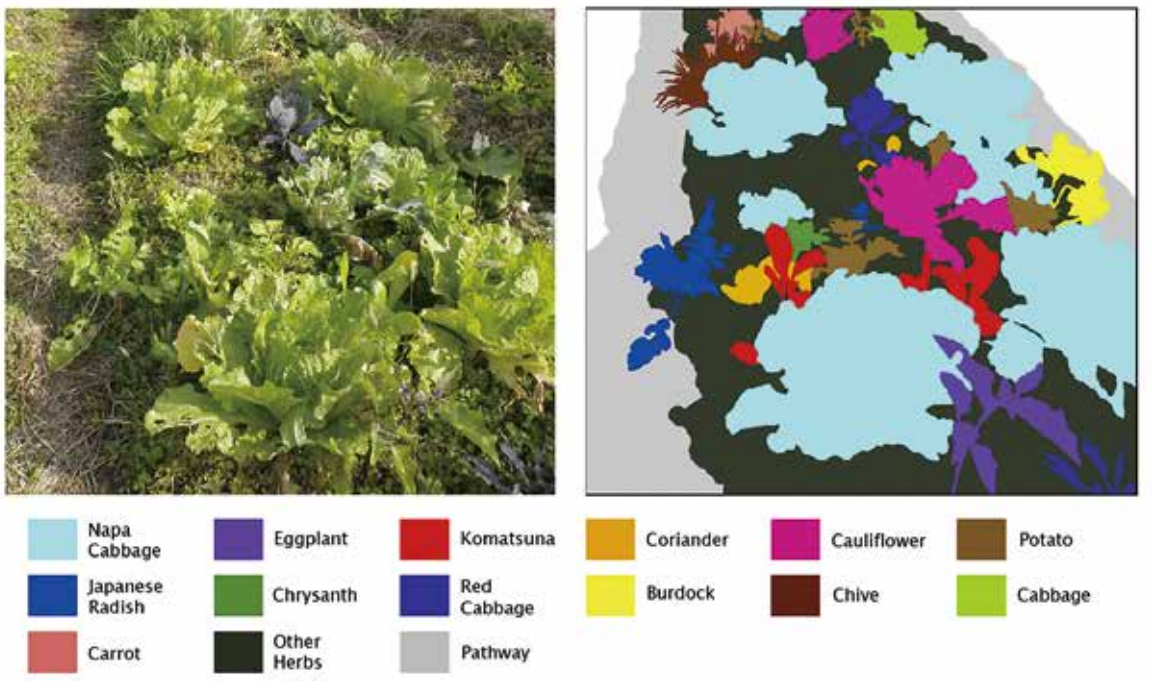
Conventional agriculture is premised on the use of tillage, fertilizers, and chemicals regardless of its scale, which has led to the destruction of the environment and reduction of biodiversity. Some reports assert that continuing the current agricultural practices based on these three elements (tillage, fertilizers, and chemicals) is no longer feasible[2], and others point to the danger of causing rapid and irreversible destruction of the ecosystem on a planetary-scale if the reduction of biodiversity continues unabated[3]. Many biologists are warning that the sixth mass-extinction event in the history of our planet is already underway as a result of agriculture and other human activities. The radical transformation of agriculture systems has become an overriding priority in pursuing the sustainability of human society.

3. Synecoculture

In response to this situation, Sony Computer Science Laboratories (Sony CSL) has launched the Synecoculture Project.

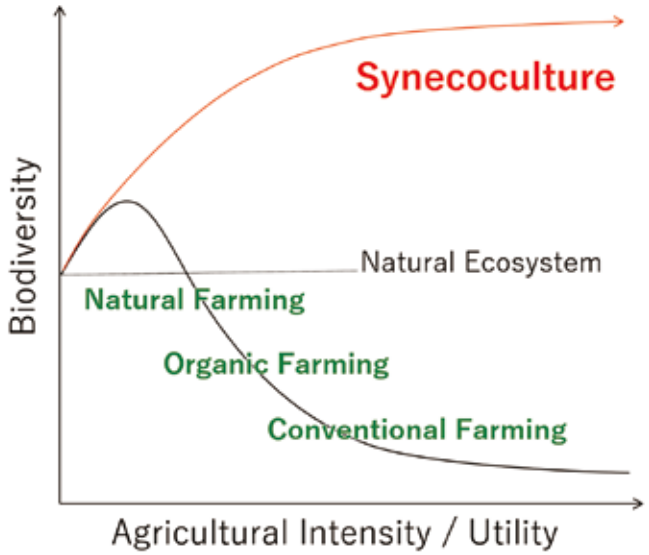
The synecoculture concept was developed by Takashi Otsuka of Sakura Shizenjuku Global Nature Network and was scientifically formalized as a farming method by Masatoshi Funabashi of Sony CSL[4]. As a farming method, synecoculture is also aimed at contributing to sustainable food production, protection of biodiversity, improvement of human health, alleviation of poverty and depopulation, etc.[5] It is characterized by a departure from the above three elements of conventional agriculture (tillage, fertilizers, and chemicals), wherein a wide variety of plant species are densely cultivated together (Figure 1) to achieve a level of biodiversity higher than that of the natural state, in order to produce a variety of food products in a sustainable manner. It aims to fundamentally surmount the current trade-off between biodiversity and productivity and achieve a high level of balance between utility and diversity of the farm ecosystem

Figure 1: Left photo shows part of a plot in a synecoculture farm, and right figure shows the plant species within that plot.



by enabling humans to control the farm ecosystem based on ecological information (Figure 2).

Figure 2: Relationship between agricultural intensity and biodiversity for different farming methods



4. Experiments in Burkina Faso

Production experiments have been conducted since 2015 by local residents in Burkina Faso, a low-income country south of the Sahara Desert. From a state of devastation due to the substantial destruction of the soil caused by traditionally continued conventional farming, the introduction of synecoculture has resulted in the restoration of the ecosystem and achieving remarkable productivity in one year (Figure 3).

From a 500-m^2 plot of land, local residents were able to achieve an income level that was 20 times higher than the per capita gross national income of Burkina Faso. This means being able to provide the minimum necessary wage to live in the capital city of Ouagadougou from a 10-m^2 piece of farmland, pointing to a practical solution to the poverty problem through agricultural production. Other than exhibiting productivity that was 40 to 150 times higher than that of conventional farming, synecoculture was able to reverse the deteriorated condition of the soil. Calculations have also shown that if 1% of the population of Burkina Faso implements synecoculture in 7000 ha of farmland, the country would be able to totally eradicate poverty.

These achievements, with support from the Burkina Faso government and the Embassy of Japan in Burkina Faso, have led to the establishment of the African Center for Research and Training in Synecoculture (CARFS) and the launch of the African Forum on Synecoculture (the 4th forum was recently held in Tunisia). Joint research activities with the University of Ouagadougou are also now underway.

5. Contribution of synecoculture to health

Synecoculture not only enables balancing productivity and establishment of the environment in small-scale farming, but it has also been found to have substantial implications for human health.

Dietary habits, environment, and health form a tightly linked three-pronged connection (trilemma). The widespread consumption of food that contains a large amount of refined sugar, fats, and oils has further intensified the need for conventional farming practices that have high environmental impact and has aggravated the risks of chronic non-communicable diseases in humans. Traditional diets that are environmentally friendly (consumption of useful plants and animals in their natural state) have the potential to help resolve this trilemma[5].

Synecocultural products are scientifically divided into *in natura* products, which are defined as equivalent to products in their natural state, and *in cultura* products, which are the products of conventional agriculture[6]. Cultured fish and farmed livestock are artificially and excessively fed beyond their natural state, and are fattened to increase their commodity value (the livestock feeds used are also produced as *in cultura* products, wherein food

Figure 3: Changes observed in the experimental farm in Burkina Faso
From a condition of not having even weeds grow when the land was left untended, to one in which useful plants have grown so thick as to hide the soil within one year.

production is cycled in the *in cultura* state). In the same way, crops cultivated using conventional farming receive excessive amounts of fertilizer and are grown in soils that are constantly tilled in a manner inconceivable in the natural state. In other words, the metabolic state of conventionally grown vegetables is similar to that of fattened livestock, and therefore may be likened to a plant version of the metabolic syndrome. In their natural state, plants interact with their surrounding ecosystem as they are faced with various nutritional deficiencies, enabling them to produce different kinds of bioactive compounds that subsequently contribute to the health of the animals that feed on them. Monocultured crops that grow by absorbing fertilizers from tilled soil have most likely lost some of the health benefits that are vital for our metabolism.

We have in fact received many reports of health improvement from consumers of vegetables and tea produced through synecoculture. Although these are based on the consumers' subjective experience, which may include some bias, we have observed a certain level of commonality in the way by which their symptoms have improved, indicating that these observations are empirically reproducible.

We therefore conducted some objective analyses based on these observations. In a metabolome analysis, we have demonstrated that synecoculturally produced coarse tea contains compounds that affect our in vivo metabolic pathways to a higher extent than conventionally produced coarse tea. Further, after providing both synecoculturally produced coarse tea and conventionally produced coarse tea to a rehabilitation facility for elderly persons, we found that synecoculturally produced coarse tea is more effective in improving activities of daily living in the subjects (comparison through a double-blind experiment).

Synecoculture contributes not only to environmental preservation and sustainable food production, but also to health promotion, and we are therefore conducting further research on the relationship of these three elements.

6. Current status and future plans

We have seen the potential of the widespread implementation of synecoculture in contributing to the solution of various issues being addressed through the SDGs. Synecoculture is now being practiced in other countries aside from Burkina Faso.

In the international arena, the UniTwin UNESCO Complex Systems Digital Campus program has launched a project to achieve World-wide Wellbeing in the context of the SDGs with synecoculture as its leading initiative[7]. With the establishment of the Decentralized Autonomous Organization, a decentralized society based on next-generation Internet technologies, science is seen to play a more significant role in society, as its relationship with the management of the real world and of industries become increasingly interactive and real-time. In addition to the three independent powers that constitute the power of the state, namely, legislative, executive, and judiciary; science, which carries out measurement and evaluation of laws in various practical ways, will be necessary as a "fourth independent power" that will serve as the guardian of sustainability, in order for the current social systems to implement effective decisions pertaining to sustainability.

There are also challenges, however, that synecoculture must overcome. One is the vast amount of information needed for putting together and making use of the complex relationships within the ecosystem. Extensive information-processing is needed to digitalize multifarious variables and conditions—including data on the diverse species of plants and insects, regional climate, soil properties, indigenous vegetation, previous crop growth conditions, invasive weed species, vegetation plan for the following years—and to achieve optimization based on relationalism. Synecoculture may also be considered, therefore, as an attempt to transform agriculture into an information industry.

We have developed a "Megadiversity management system" as a software that supports humans in properly managing these complex phenomena surrounding synecoculture. We are currently pursuing research and development so that the system will be able to contribute, not only to synecoculture, but also to all human activities, by enhancing human intelligence through the effective use of machine learning, various sensors, and individual empirical knowledge.

We believe that by integrating Sony's technologies as well as those of other companies to enable the realization of an abundant society where everything coexists together, the system and its value chains will eventually evolve to serve as the next generation standard.

References
[1] Wall D *et al.* "Soil biodiversity and human health" Nature 528, 69-76, (2015)
[2] IAASTD. "Agriculture at a Crossroads: Synthesis Report" (2008) https://www.globalagriculture.org/fileadmin/files/weltagrarbericht/IAASTDBerichte/SynthesisReport.pdf (Accessed on 2018.07.07)
[3] Barnosky AD *et al.* "Approaching a state shift in Earth's biosphere" Nature 486, 52-58, (2012)
[4] Funabashi M. "Synecological farming: Theoretical foundation on biodiversity responses of plant communities" Plant Biotechnol. 33, 213-234, (2016)
[5] Tilman D & Clark M. "Global diets link environmental sustainability and human health" Nature 515, 518-522, (2014)
[6] Funabashi M. "Human augmentation of ecosystems: objectives for food production and science by 2045" npj Science of Food 2, Article number: 16 (2018)
[7] http://www.cs-dc.org/

Cover Art

Picture of kabuki actor Iwai Kumesaburo as Osen in Crescent Moon (Mikazuki).

Utagawa Toyokuni (1769-1825)

Collection of the Art Research Center (ARC)
Ritsumeikan University
Object number: arcUP0037