
Introduction: restructuring social metabolism for sustainable agriculture

Guest Editors:

Shunsuke Managi*

Graduate School of Bio-Applications and Systems Engineering,
Tokyo University of Agriculture & Technology,
Koganei, Tokyo 184-8588, Japan
E-mail: managi@cc.tuat.ac.jp
*Corresponding author

Masayuki Horio

Graduate School of Bio-Applications and Systems Engineering,
Department of Chemical Engineering,
Tokyo University of Agriculture & Technology,
Koganei, Tokyo 184-8588, Japan
E-mail: masa@cc.tuat.ac.jp

Yutaro Senga

Faculty of Agriculture, Department of Ecoregion Science,
Tokyo University of Agriculture & Technology
Fuchu, Tokyo 191-0016, Japan
E-mail: senga@cc.tuat.ac.jp

Biographical notes: Dr. Shunsuke Managi has been an Associate Professor at Tokyo University of Agriculture and Technology since 2003, and a consultant at the CSR Institute Inc. since 2004. He has published papers on environmental and natural resource economics, productivity analysis, and international trade in refereed journals such as *Journal of Environmental Economics and Management*, *Land Economics*, *Economics Bulletin*, *Energy Policy*, *Environmental Systems Research*, and *Marine Resource Economics*.

Dr. Masayuki Horio has been a Professor at Tokyo University of Agriculture and Technology since 1991. He has published more than 150 papers in refereed journals such as *Environmental Science and Technology*, *Chemical Engineering Science*, *Powder Technology*, etc. Since 1997 he has been one of the two regional editors of *Powder Technology* published by Elsevier Science, co-author of *Circulating Fluidized Bed*, Chapter II, published in 1996 by Chapman and Hill, and *Handbook of Fluidization and Fluid-Particle Systems* in 2003 by Marcel Dekker. Recently, he became a leader of the ESTeC group (Evolution and Survival of Technology-based Civilization) of the university, in which sustainable agriculture is one of the major issues.

Dr. Yutaro Senga has been a Professor at the University of Agriculture and Technology since 1996, a Board Member of Japan Rural Planning Association since 2001 and a Board Member of the Japanese Society of Irrigation, Drainage and Reclamation Engineering since 2001. He has worked as a Council Member of Ministry of Agriculture, Forestry and Fisheries as well as of National Land Agency. He has published books such as *Soft-science on Water Resources* (1989) and papers on water resources planning, water environment, rural landscape, rural re-development planning, and resources recycling regional system in refereed journals.

This special issue of the *International Journal of Agricultural Resources, Governance and Ecology* contains a set of papers related to sustainable agriculture. The main objective of this special issue is to provide a collection of papers in order to answer some of the main questions related to how to restructure the social metabolism for sustainable agriculture. Some themes of the papers include

- governance for sustainable agriculture
- application of new technologies toward sustainable agriculture.

Agricultural policies have changed dramatically, especially since the end of World War II. Agricultural productivity increased due to new technologies, mechanisation, increased chemical use, specialisation and government policies that favoured maximising profit or revenue. These changes allowed fewer farmers with reduced labour demands to produce the majority of the agricultural industry products. Although these changes have had many positive effects and reduced many risks in farming, there have also been significant negative effects. Prominent among these are soil depletion, groundwater contamination, the decline of family farms, and the disintegration of economic and social conditions in the communities.

Responding to the above problems, comprehensive analysis of European environmental policies is provided in the paper by Takashi Toyoda and Shunsuke Managi. European policies are selected since their policies seem to recognise the importance of sustainable agriculture well than other countries. Three policies, which are environmental taxes, tax exemptions, and the environmental agreement, i.e., covenant, are assessed in their study. Although it is difficult to assess each of them separately, each method does seem to show significant effects to reduce the environmental bads.

Less-favoured areas (LFAs) face different culture and fields while the other regions do not have to worry about. In LFAs of many European Union countries except several Southern European Countries, most of the farmers are engaged in extensive livestock farming. In Japan, LFAs constitute most of the farmland use in terraced paddy field farming, and aging farmers of small farm sized households engaged in inefficient rice production. Direct payment policy to farmers in Japan was formulated in 1999 with the same scheme in the European Union enforced since 1975. The paper by Masayuki Kashiwagi evaluates the constitution, significance and limitations of direct payment policy to farmers in hilly mountainous areas in Japan by comparing the system in EU especially focusing on the UK.

The role of forest carbon sequestration has received increasing attention as concern of climate change has grown and the discussion of mitigation options progressed.

For example, Japan plans to use forest absorption, or sinks to achieve 3.9% points of the 6% cut in greenhouse gases from the 1990 level under the Kyoto Protocol. However, there are very few studies assessed the management of forestry. The paper by Satoshi Aoyagi and Shunsuke Managi evaluates efficiency of forest management in Japan and show that efficiency of forest management decreases over 25 years period from 1975–2000 on average. The study indicates a substantial variation in efficiency across prefectures with a potential for output saving in the range of 40% on an average. The econometric results seem to support the hypothesis that government subsidies had an adverse effect on economic performance of forestry sector. The paper encourages the importance of re-considering the alternative policy for sustainable forestry.

Water efficiency improvement in agricultural production has emerged as a formidable challenge to improve the productivity in the water-scarcity areas of the world. In China, one of the important agricultural bases is located in the northern semi-arid region by which a large portion of wheat and corn demand is supplied. With rapid industrialisation and continuous increase of grain demand, the role of the north region and water efficiency improvement in grain production becomes increasingly significant and urgent in China. The study by Shinji Kaneko, Katsuya Tanaka, Tomoyo Toyota and Shunsuke Managi measures the water efficiency in agricultural production in China from economic perspective and evaluates the incentives to increase water efficiency.

Tea is considered to be one of the most popular natural beverages. Sri Lanka ranks first in the tea export business with 20% of the world market share. The paper by J.M.J.K. Jayasinghe and Takashi Toyoda analyses organic tea that is emerging as a major farming activity in Sri Lanka. The results indicate that there is a great potential to increase production by 55% through efficient use of the present technology. A significantly positive relationship is also found between technical efficiency and training of farmers. Several specific policies for the development of the organic tea smallholding sector in Sri Lanka are suggested.

The agricultural system consists of ecological, economic, and sociological components interconnected as complex networks. To achieve sustainable agriculture, it is important to determine the governing rules of their nonlinear and complex systems, which is a relatively new issue in science fields. The paper by Kenshi Sakai, Shunsuke Managi, and Katsuhiko Demura utilises the real data of piglet market data to understand nonlinear dynamics. The post-second oil crisis data showed that both short-term and long-term predictions were possible with a high degree of accuracy. The pre-crisis data showed the possibility of short-term prediction, but the impossibility of long-term prediction. The results implied that the dynamics were chaotic in the pre-crisis period. Since government fixed price system was introduced after the second oil crisis, they conclude that government policy contribute to stabilise the market.

Social science and cultural perspectives on technology play an important role in understanding technology system in agriculture. Fumihiko Satofuka defines technological culture as a complex system of certain technological principles, in connection with a set of value orientations, such as worldview, attitudes towards living things, productivity and labour. Satofuka elaborates three models of the technological culture, on the basis of ethnographical data of three cultures, namely Asian culture, European culture, and Latin American culture. These three cultures are radically different from each other, with no direct contact until the second half of the 19th century. By taking three cultures as points of reference, the paper relativises and objectifies more efficiently one of the three points, including the observer's culture.

Applications of new technologies are crucial in sustaining agricultural productions. The community-based precision farming is a new regional farming system to obtain high profitability and reliability under regional and environmental constraints, promoted by farmers armed with wisdom and technology platform, through creating both information-oriented fields and information-added products, with supply chain management of field to table. The paper by Sakae Shibusawa describes a Japanese Model of community-based precision farming and learning groups of farmers and companies. Two participating local learning groups are discussed. One aims at realising a total system of technologies in precision farming. The other strives to produce information-added products from information-oriented fields, as new branded products. The first action was a market research on information-added products through in-shop experiments.

There is a well-known hypothesis in policy communities called Porter hypothesis which suggests tougher environmental regulations could spur technological growth, leading to an increase in productivity of market outputs, simultaneously providing greater environmental protection. Although there are abundant theoretical analyses, there is a lack of empirical analysis in economics and governance literature. The paper by Shunsuke Managi tests the Porter hypothesis in US agriculture using state level data from 1973 through 1996. Productivity indexes, which is dual to the profit function and does not require the choice of input-output orientation, are measured with and without environmental factors. Managi also tests the direction of causality between technological progress and stringent environmental regulation, and find support for a recast version of the Porter hypothesis, but rejecting a standard version of the Porter hypothesis.

The authors of this special issue identify a number of measures that could improve the sustainability in the agricultural system. To conclude, these contributors shed light on a number of policy issues, mainly related to the evaluations of policies, science, and new technologies. A growing interest has emerged during the past decade to finding the role of the agricultural governance in promoting practices that contribute to many social problems. This movement for sustainable agriculture is gaining increasing support by new policies and technologies within mainstream agriculture. Sustainable agriculture addresses many environmental and social concerns, and also it offers innovative and economically viable opportunities for community and policymakers in the entire agricultural and industry system.