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COMMENTS

Toward Agriculture Green Development

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The term Agriculture Green Development (AGD) was introduced by the 19th National Congress of China's CPCC in 2017 as a name for the national strategy of sustainable development to realize green development. This national strategy aims at fundamental solutions for the so called three rural issues: (1) agriculture, (2) rural areas, and (3) the livelihood of farmers. It emphasizes the need for the joint development of sustainable agricultural practices, a green countryside and a flourishing rural population.

This is an important and much needed initiative. There are many reports about the impressive increases in food production in China over the last few decades that have achieved food security. However, there are increasing numbers of scientific reports about the negative impacts of this; the rapid increases in crop and animal production have created serious environmental problems, while farmers have received limited benefits and the countryside and natural habitats have been insufficiently protected. At the same time, there are many scientific reports that provide possible solutions for these problems. All three categories of reports are convincing; there are both needs and opportunities for fundamental changes, for fundamental improvements in food systems and in the protection of natural habitats and ecosystem services.

The pressing question is how to organize and implement AGD effectively and efficiently. Also, how to achieve sustainable agricultural practices, a green countryside and a flourishing rural population in a country as large and diverse as China is a key question. Some argue that the government will direct the invisible hand of the market and will organize the transformation process, suggesting that if any government can do this, it will be the Chinese government, together with other actors and rural people. Although this statement might be true, the complexity of the task should not be underestimated.

Science and scientists will have to make an important contribution to this. Scientists will have to create the knowledge, technology, institutions and capacity for developing sustainable food systems and a green environment, countryside and food industry, together with other actors. They will have to lay the scientific foundation for green food systems, which are productive and resilient, economically profitable, environmental sound, and contribute to landscape diversity and ecosystem services. These are formidable objectives.

The development of science and technology in China is as impressive as the development of its economy and high-speed railway system over the last few decades. This is promising, as AGD requires rapid improvements in knowledge, technology and institutions. In practice, it might be more complicated than implied from the previous sentences. Above all, there is need for actors who are able to utilize the improved knowledge, technology and institutions to achieve AGD. A new generation of scientists and entrepreneurs have to take the lead. Actors who are able to contribute to AGD directly, i.e., the joint development of sustainable agricultural practices, a green countryside and a flourishing rural population. A new generation of interdisciplinary and internationally trained scientists who will be able to have a leading role in academia, industry and policy to further develop sustainable food systems while concurrently protecting and/or restoring natural habitats and ecosystem services. There is an increasing need for interdisciplinary approaches and expertise to be able to address the increasing complexity of the societal challenges of Chinese agriculture in a globalized world at a scientifically advanced level. At the same time,

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appropriate training programs have to be developed for current and future farming generations and extension officers.

Also, much may be learnt from history and the experiences in other countries. China has a very rich agricultural history having been an agrarian society for some 8000 years. It has also been an innovator of circular economy, especially in recycling household wastes. Much has changed over this long history. By studying history, we can learn why some practices and cultures have changed and others not. Likewise, we can learn why some nations have prospered much longer than others, and why some nations have failed.

AGD resembles sustainable intensification, which has its origin in the 1990s and has been embraced since then by many countries and international organizations, including the United Nations FAO and the World Bank. There is an ongoing debate on what constitutes sustainable intensification[1,2]. There is discussion about the clarity of its definitions, principles and practices. It is argued that both words in the phrase sustainable intensification need to carry equal weight, which in practice means an all-inclusive and explicit cost-benefit analysis, and subsequent weighing of trade-offs, based on scientifically sound and shared norms, which so far seem to be lacking[3].

AGD will also need accountable definitions, objectives, principles and practices, just like sustainable intensification. It requires actions on multiple fronts. It needs to be viewed over space and time in order to include the direct and indirect effects, and the consequences of its developments on other regions and future generations. The indicators used to quantify and assess AGD will have to reflect these different temporal and spatial scales.

As with sustainable intensification, much can be done with utilizing and synthesizing existing knowledge, but in a different, broader context. AGD requires systems analyses, system thinking and integrated approaches, at different spatial and temporal scales. There is need for systematic analyses of the drivers, strength, weaknesses and trade-offs of current food production systems and of more sustainable food production systems. A greater understanding of how the various sectors and actors of the food systems interact is needed, for different regions. At the same time, there is need for new knowledge, insights and technologies.

The efforts needed to achieve AGD offer great potential for strengthening national and international cooperation and strengthening joint research projects. The challenges and opportunities are both enormous. Many of the challenges for AGD are universal across the rapidly developing countries of the world, suggesting that international cooperation offers win-win situations. China has a huge and rapidly-developing disciplinary research base, but is still rather weak in interdisciplinary and transdisciplinary knowledge and system approaches capacity. Again, international cooperation may offer win-win situations, as various foreign universities and research institutions are advanced in system thinking and integrated approaches, and may seek interesting case-studies. The open-door policy introduced in the 1980s in China has greatly facilitated research collaboration between China and other countries over recent decades; it is felt that the national strategy for sustainable development and AGD will further strengthen this cooperation.

The papers in this special issue reflect our current understanding of the challenges and opportunities of AGD. We are just at the beginning of what seems to become a fascinating transformation trajectory. Likely, this trajectory is not linearly but intermittently, in fits and starts. New research findings and insights related to AGD will hopefully be reported regularly in *Frontiers of Agricultural Science and Engineering*.

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