**Multiple roles for Landscape Ecology in future farming systems**

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Farming faces new and urgent pressures, with an array of mounting social, environmental and economic challenges, and growing public and political expectations for improved stewardship of natural resources. Responses demanded of farming include changes that reduce greenhouse gas emissions, improve environment quality, restore and increase biodiversity, feed a growing global population, and support national economies, all while providing livelihoods for farmers themselves. Further, there is an immediacy and urgency to respond to the challenges as multiple planetary boundaries are exceeded or approached [1]. It is recognised that changing climate is impacting the capacity of farming and forestry across nations and regions [2]; with both flooding and drought events increasing in frequency [3], and water quality and quantity becoming increasingly problematic. Biodiversity continues to decline, biosecurity threats abound, market and consumer influences are changing, and there are heightened concerns around the relationships between animal protein and human health, with increasing recognition of the nutritional value of different foods and diet in relation to human well-being. There is also growing public intolerance for the cumulated environmental impacts from the agricultural sector, requiring a need to adopt more of a social licence to operate into the future.

These pressures and demands challenge current patterns and practices of land use worldwide, and require development of sustainable agriculture and land use practices that can address the climate, biodiversity, population, and water, energy, and food security issues [4, 5]. Deliberate and directed change in land systems and practice requires clear and careful thought and guidance, based on best available evidence. Although farming continuously responds to market and other signals, it is perhaps less responsive to signals from factors typically considered as externalities, such as costs to natural capital. A growing body of information, from a diverse set of disciplines and perspectives, is being generated and has potential to inform choices and decisions for future farming. Knowledge of the greenhouse gases associated with different farming types and activities have been established, impacts of land clearing and intensification on biodiversity are well known, although the specific details contested, and impacts of land management on erosion and water quality and quantity are becoming increasingly recognised. The task of assembling, synthesising and integrating these multiple evidence bases and objectives and priorities to make informed decisions about specific land, land uses and practice change requires support.

Although this support will come from multiple sources, landscape ecology can play a particularly significant role. A number of authors have discussed the relationships, overlap and complementary perspectives of land systems science, landscape ecology, and political ecology, as well as their links to sustainability science [6-9]. All are interdisciplinary in scope and approach, recognise and address land as a coupled human-environment system, and have a focus on land system dynamics. Landscape ecology also has a well-developed set of tools and methodologies for analysis across multiple spatial, temporal, and organisational scales.

The holistic and interdisciplinary nature of landscape ecology positions it not only to address the specific human and environmental challenges facing agriculture, but also to offer advice on how to plan, design, modify and develop understanding for new land use patterns and farming systems in specific geographic landscapes that can function with best environmental, economic and social outcomes in mind [6]. Landscape ecology can provide appropriate tools, approaches and frameworks that can facilitate the action, knowledge and advice required to help work towards the creation of future farming systems that meet societal needs, respond to the environmental challenges and that can sit within sustainable landscapes and societies. However, it is important that these can be practically applied and are seen to be relevant for policy makers and farmers to be able to implement.

The papers in this special issue explore the potential for these contributions and discuss the evolving roles for landscape ecology in future agricultural systems. Papers individually focus on specific parts of the challenges facing farming for the future. How will it be possible to incorporate catchment scale environment quality objectives into field and farmland use and land management practices? What are the land and landscape implications of alternative crops and husbandry systems intended to improve nutritive value of food and human diet and well-being? How can landscape ecology concepts be more practically applied to assist farmers and policy makers facilitate sustainable land management decisions and plan and design future farm landscapes? How can landscape ecology assist in the establishment of effective transdisciplinary projects that focus on the co-development of strategies to identify and address problems? How can knowledge and cultural connections and values that indigenous people associate with landscapes be incorporated into more western production systems for more sustainable outcomes including the potential for diversification of agricultural production systems towards alternative practice which integrate with customary knowledge and practice towards the growth and harvest of novel bushfoods and capitalise on organic practices which are non-destructive?? What are current potentials for geodesign and geospatial technology to propose and evaluate alternative patterns of farming land uses and create multifunctional landscapes? What lessons does a long view of land use change in agriculture provide for understanding future change management?

Additionally, taken together as a set, the papers address a variety of questions about the nature of future farming systems, and the changes necessary to achieve those future systems, as well as the utility and capacity of landscape ecology as an approach to integrate and synthesize scientific information for effective regional and global landscape management. It is important that this integration and synthesis aims towards practical outcomes that create sustainable landscapes and futures for environments and people, therefore landscape ecology needs to demonstrate its relevance and develop in basic, strategic and applied directions, and in participatory co-design of land management practices at various relevant scales.

Specific questions for development and application of approaches embedded in landscape ecology include:

* How can landscape ecology assist in the planning, design, modification and development of new farming landscapes with best environmental, economic and social outcomes in mind?
* How can landscape ecology contribute towards developing land systems and land management practices for specific landscapes, that meet the goals of increased nutritious food production in the face of market and climatic variability whilst reducing environmental impacts and enhancing natural capital?
* How can landscape ecology assist in the transformative changes required to the socio-economic and environmental systems of rural areas and food production for the future?

**Keywords:** *agricultural landscapes, cultural landscapes, ecosystem services, land systems, land use, landscape ecology,**landscape planning and design, natural capital, socio-ecological systems, sustainable landscapes,*

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