Organic World Congress 2020 | FRANCE

SEPTEMBER 21ST TO 27TH, 2020 IN RENNES
AT THE COUVENT DES JACOBINS • RENNES MÉTROPOLE CONFERENCE CENTRE
www.owc.ifoam.bio/2020

OWC 2020 Paper Submission - Science Forum

Topic 1 - Ecological approaches to systems' health

OWC2020-SCI-1317

DOES ORGANIC MANAGEMENT LEAD TO HIGHER LANDSCAPE HETEROGENEITY IN LARGE SCALE FIELD CROP PRODUCTION?

Andrew M. Hammermeister* [1,2], Wenjie Xu[2], Brandon Heung[2]

[1]Organic Agriculture Centre of Canada, [2]Department of Plant, Food, and Environmental Sciences, Dalhousie University, Truro, Canada

Preferred Presentation Method: Oral or poster presentation

Full Paper Publication: No

Abstract: Organic agriculture is expected to maintain or enhance biodiversity in the landscape. Over the past few decades, studies have confirmed that organic management can provide a higher level of biodiversity than conventional management. Landscape heterogeneity, i.e. the diversity of features on a landscape, is positively associated with biodiversity. Large scale field crop production increasingly utilizes large equipment to capture efficiencies of scale. Farmers are known to remove landscape features such as wetlands, woodland patches, and fence lines that interfere with field operations. Here we hypothesize that land under organic field crop management has higher landscape heterogeneity than that under conventional management. To study this, we will identify 120 paired, organic and conventional fields in Saskatchewan, Canada, where landscape heterogeneity will be assessed. For each field, a manual digitization of major landscape structures is carried out and landscape ecological metrics are applied to characterized landscape heterogeneity. Results will help us identify the relationship between landscape heterogeneity and farming systems and specific landscape structures that contribute to the greatest differences between the management systems. These results will help farmers and policymakers better understand the importance of landscape heterogeneity on agricultural systems.

Introduction: In 2019, the Food and Agriculture Organization (FAO) released "The State of the World's Biodiversity for Food and Agriculture" report, which warns us that many key components of biodiversity are in decline. There is ample evidence to suggest that conventional management is playing a predominant role in biodiversity loss (Tscharntke, 2005) and environmental contamination (Bennett, 2004). In Canada, the third and seventh goal of the report, "2020 Biodiversity Goals and Targets for Canada", indicates that wetlands and many other landscape structures should be preserved for ecosystem services and biodiversity. Organic management is the agricultural production process that is guided by principles of sustainability and regulated standards to meet the expectations of consumers (Council Regulation, 2007; IFOAM, 2005).

Previous studies have confirmed that organic management is more effective in sustaining biodiversity and ecosystem services (Mace, 2012). It is also understood that landscape heterogeneity is positively associated with ecology in agricultural landscape (Benton, 2003). However, few studies have directly investigated the relationship between landscape heterogeneity and ecosystem services; and of the studies that did, most were focused in European countries. Consequently, the results are not transferrable to Canada where agricultural practices operate at a far larger scale and in a different environment. Hence, this study will be focussed on the prairie landscapes of Saskatchewan—Canada's most significant agricultural production area with the second largest land area of organic operations in the country (Statistic Canada, 2017; Canada Organic Trade Association, 2018).

The concept of landscape heterogeneity consists of two elements: compositional and configurational heterogeneity. The former describes the number of land cover types while the latter describes the complexity of the spatial distribution of those land cover types. To quantify both types of heterogeneity, metrics from landscape ecology are typically used. This study aims to determine if landscape heterogeneity is higher under organic management than under conventional management; and if so, determine which landscape features are most different between organic and conventional management. We hypothesize that (1) organically managed land has a higher level of landscape heterogeneity than conventionally managed land; (2) a higher proportion of lowland areas will be cultivated under conventional management than under organic management since equipment such as sprayers can travel through or reach into wet lowlands more easily than tillage equipment; and (3) the difference in heterogeneity between organic and conventional land will be greater in a topographically complex landform type than in a flat landscape.

Material and methods: An inventory of municipal maps will be conducted to find municipalities where organic land is clearly identified. A target of 120 pairs of organic and conventional fields will be identified at the scale of quarter sections (160 ac, 65 ha). Quarter sections are typically the smallest unit of agricultural land ownership in Saskatchewan and thus management; an individual farm may consist of several if not numerous quarter sections that may be connected or in isolation. Once an organic quarter section has been selected, an immediately adjacent conventional quarter section will be identified as its pair in order to minimize differences in surficial landform geology within the pair. Surficial geology of the pair will be recorded and classified to allow comparisons of organic and conventional land heterogeneity within and among landform types.

Aerial photo data will be acquired and the landscape features will be delineated, classified, and converted through manual digitization to polygons of i) cultivated upland, ii) cultivated lowland, iii) perennial mixed land (including trees, shrubs, herbs and wetlands), and iv) shelter belts. Once digitization of a field is complete, it will be converted to grid-based (raster) data where Fragstats 4.2 will be used to calculate various landscape metrics of interest. T-tests and two-way ANOVA will be used to determine if differences between management types and landforms are statistically significant.

Results: At the time of submission, only a pilot study has been completed. Five suitable pairs of organic and conventional quarter sections were identified in the Rural Municipality of Moose Creek. In four of the five pairs, fields under organic management had higher landscape heterogeneity than conventional fields.

Discussion: This research is novel as there are few studies that assess landscape heterogeneity under organic versus conventional management systems, and no literature exists for the Canadian prairies. Once this research is completed the results are expected to have important impacts. If the organically managed land has higher heterogeneity than the conventionally managed land, then this would suggest that organic management is inherently more likely to support higher biodiversity beyond that provided by weed populations and the absence of synthetic pesticide use. Such a difference between farming system could be attributed to a) a difference in attitude toward habitat conservation, b) practical differences in equipment which limit the removal of natural features such as wet lowland areas, c) the requirement to maintain buffer zones along conventionally managed neighbouring fields, or d) a combination of the above. If there is no difference between organic and conventionally managed fields then the differences in attitudes and/or practical constraints are negligible. This would then lead to the question of whether there should be a difference. Organic farmers do receive a premium for their field crops to compensate for lower yields and potentially higher production costs. However, is this premium enough incentive for organic farmers to maintain habitat for biodiversity? Further, should organic standards require farmers to maintain landscape features for biodiversity, and should they be further compensated for it?

The results of this research should provide fodder for discussion within the organic community about expected outcomes of organic management including maintaining biodiversity. It could prompt development of standards encouraging adoption of practices that maintain habitat and inform discussions among policy makers. The results of this research should be transferable to other areas of large-scale field crop production.

References: Bennett, R. et al. (2004) Environmental and human health impacts of growing genetically modified herbicide-tolerant sugar beet: a life-cycle assessment. Plant Biotechnology Journal 2, 273–278.

Benton, T.G. et al. (2003) Farmland biodiversity: is habitat heterogeneity the key? TRENDS in Ecology and Evolution. 18, 182-188

Canada Organic Trade Association (2018) Organic Agriculture on the Prairies.

Council Regulation (EC) June 2007 on organic production and labelling of organic products and repealing Regulation (EEC)

IFOAM (2005) Principles of Organic Agriculture

Mace, G.M. et al. (2012) Biodiversity and ecosystem services: a multilayered relationship. Trends in Ecology and Evolution 27, 19-26.

Statistic Canada (2017) Saskatchewan remains the breadbasket of Canada.

Tscharntke, T. et al. (2005) Landscape perspectives on agricultural intensification and biodiversity-ecosystem service management. Ecology letters. 8, 857-874.

Disclosure of Interest: None Declared

Keywords: biodiversity, landscape heterogeneity, organic agriculture