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Innovations in temperate agroforestry: the 13th North American Agroforestry Conference

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Abstract The content of this Special Issue of Agroforestry Systems was developed from presentations at the 13th biennial North American Agroforestry Conference (NAAC) of the Association for Temperate Agroforestry (AFTA), held in Charlottetown, Prince Edward Island (PEI), Canada on June 19–21, 2013. The conference attracted over 100 participants and included 2 days of plenary, concurrent and poster presentations. The eleven manuscripts in this Special Issue derive from recent temperate agroforestry research projects in North America that were presented at the conference and also include one manuscript from Germany. Overall, the manuscripts reflect the diversity of agroforestry practices throughout North America and its multi-disciplinary nature, including socioeconomic as well as biophysical studies. The conference marked a new stage in the development of temperate agroforestry, as members of the newly formed European Agroforestry Federation (EURAF) actively participated in it. The development of closer ties and collaborative projects between European and North American agroforesters bodes well for the advancement of temperate agroforestry in these two regions.

Keywords Ecology · Greenhouse gas · Alley cropping

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Introduction

According to the Association For Temperate Agroforestry (AFTA), North America agroforestry includes a number of practices in which trees/shrubs are used in agricultural production systems (AFTA 2014). They can mostly be categorized as shelterbelts/windbreaks; alley cropping; riparian buffers; silvopasture and forest farming (Gold and Garrett 2009). Agroforestry practices are used in agricultural systems for economic and/or environmental reasons and provide benefits to landowners/producers as well as to the public (Kant and Lehrer 2004; Kulshreshtha and Kort 2009). Examples of public benefits from agroforestry are the protection of soil or water, provision of habitat or sequestration of carbon. Private benefits include the protection of crops, direct products from trees or shrubs (e.g. wood, fruit, nuts, maple syrup) or the products of forest farming, in which the trees provide shade and protection for valuable understory species. Although landowners generally want to be good stewards of their land, they are usually more strongly motivated to use agroforestry practices of practical or

economic benefit than those which have mainly environmental or public benefits (e.g. riparian buffers) (Valdivia et al. 2009). For this reason, public programs and policies play an important role in encouraging practices like riparian forest buffers, which have mainly important environmental benefits (Godsey et al. 2009; Valdivia et al. 2009).

The ecology of agroforestry, both aboveground and belowground, has a solid scientific basis (Jose and Gordon 2008). Windbreaks, because they have been planted for over 100 years in the western plains of the US and Canada, as well as elsewhere, have been studied for many years (Brandle et al. 1988). Since the uptake of agroforestry and other environmentally beneficial practices is generally voluntary, with some exceptions, such as regulated riparian buffers, agroforesters and researchers need to further develop agroforestry knowledge in all related subject areas that are important to landowners, including ecology, management, socioeconomics, and policy. This knowledge then needs to be made available through education and training, so that landowners can make informed decisions about why and how to adopt agroforestry in their farming systems. The articles contained in this Special Issue show that North American agroforesters continue to significantly advance this knowledge.

The 13th North American Agroforestry Conference (NAAC)

The 13th NAAC of AFTA was held jointly with the Poplar Council of Canada (PCC), a long-standing national committee that focuses on the science and use of the family *Salicaceae* (i.e. poplars and willows). The participants were mostly from Canada and the United States, but participants from Europe and Morocco were also welcomed. The 2 days of plenary, concurrent and poster sessions included 64 oral presentations and 25 poster presentations. The organizers were from Agriculture and Agri-Food Canada, the PEI Federation of Agriculture, the PEI Soil and Crop Improvement Association, the PEI Department of Agriculture and Forestry and the University of New Brunswick, with funding support from Agriculture and Agri-Food Canada, the United States Department of Agriculture's National Agroforestry Center and the PEI Department of Tourism. The conference marked a new stage in the development of temperate agroforestry, as members of the newly formed European Agroforestry Federation (EURAF) actively participated in the conference.

This conference was the most recent in a 25-year unbroken string of biennial NAACs that began at the University of Guelph in Ontario, Canada in 1989. AFTA (www.aftaweb.org) seeks to bring together agroforestry researchers, technology transfer professionals, policy makers, landowners and practitioners, and to promote agroforestry knowledge and adoption. AFTA addresses agroforestry practices in the North American context that include windbreaks; riparian buffers; silvopasture; alley cropping; and forest farming—practices that meet both environmental and economic objectives.

At the 2013 NAAC, special efforts were made to engage and welcome European agroforesters. The formation of EURAF in 2012 is an important development in temperate agroforestry and increased interaction between AFTA and EURAF is anticipated in the future.

Conference themes

The importance of agroforestry in landscape ecology was highlighted by keynote speaker, Dr. Jacques Baudry, Senior Scientist at France's Institut National de la Recherche Agronomique (INRA) station at Rennes (centres.inra.fr/en), who highlighted his work over many years as the research leader of multi-disciplinary teams studying the ecology of the highly complex agricultural landscapes of Brittany and Normandy, of which the dense network of hedgerows, the "bocage", is an integral part. Because similarly complex agricultural landscapes are found throughout North America, this discussion was of great interest to participants.

Two themes of the conference were the science and use of poplars and willows and the effects of agroforestry practices on agricultural greenhouse gases (GHG). Poplar and willow species are frequently included in agroforestry applications throughout North America and Europe because the family *Salicaceae* is extremely varied, with species that are fast-growing (for biomass or quick shelter), flood tolerant (for riparian systems) and/or coppiceable (for bioenergy). The PCC (www.poplar.ca) hosted poplar

and willow sessions at the conference which included presentations about the genetics, physiology and environmental and economic uses of poplars and willows. Several conference sessions addressed the theme area of agroforestry and GHG. These featured a number of current Canadian agroforestry projects under Agriculture and Agri-Food Canada's Agriculture Greenhouse Gas Program (AGGP), initiated as Canada's contribution to the Global Research Alliance on Agricultural Greenhouse Gases (www.globalresearchalliance.org). Along with other GHG-related projects from the US and Europe, these sessions were very informative.

Papers contained in this Special Issue

The eleven manuscripts that make up this Special Issue include ten from North America and one from Germany. Six manuscripts derive from research at two alley crop research sites in southern Quebec and southern Ontario in Canada. The manuscripts reflect the diversity of agroforestry practices throughout North America and its multi-disciplinary nature, including socioeconomic as well as biophysical studies.

Böhm et al. studied a novel alley cropping system near Cottbus, Germany, in which closely spaced rows of short-rotation black locust (*Robinia pseudoacacia* L.) were used as windbreaks in an alley cropping system. From wind measurements, they concluded that alternate black locust hedgerows could be coppiced at intervals, while retaining their protective benefits for the crop alleys. This system was highlighted recently at the 2nd EURAF Conference to be held in Cottbus in June, 2014 (www.agroforestry.eu). Zamora et al. studied short-rotation willow systems, harvesting 3-year-old coppiced willow in Minnesota and comparing the productivity and chemical composition of native willow clones to that of willow hybrids developed at the State University of New York. Although native willows are useful and appropriate for riparian buffers, their productivity was relatively low and the authors concluded that the willow hybrids were of most interest and needed to be established in larger plantings for further agronomic management and productivity research.

Issah et al. compared nodulation and biological nitrogen fixation by two *Eleagnaceae* shrub species, through *Frankia* associations, to that by the leguminous shrub caragana (*Caragana arborescens* L.). The North American buffaloberry (*Shepherdia argentea* Nutt.) and the Eurasian seabuckthorn (*Hippophae rhamnoides* L.), which are commonly used agroforestry species in the Canadian Prairies, were found to fix substantial quantities of nitrogen, albeit less than the caragana. Further research into nitrogen fixation by *Eleagnaceae* species is important, since these species are often used on low fertility soils.

Trozzo et al. surveyed landowners of riparian areas in western Virginia to determine their interest in planting native fruit and nut trees in riparian buffers. Modeling the results, using the previously developed Universal Theory of Acceptance and Use of Technology (Venkatesh et al. 2003), the authors concluded that newer landowners with higher incomes, derived mostly from off-farm employment, were more likely to adopt this agroforestry practice.

Serra et al. studied the effect of 600 sheep in silvopastoral plots in north-central British Columbia to control vegetation in reforested plots of spruce seedlings. Grazing by the sheep was found to be of great benefit to seedling growth, resulting in declaration of "free-growing" status by forestry regulators 7 years earlier than for similar, non-grazed sites. Although the widespread adoption of the practice is currently hampered by lack of infrastructure, expertise and socioeconomic factors, greater restrictions on herbicide use are likely to increase its development and adoption.

Three articles were derived from a 25-year-old alley crop system at Guelph, Ontario. Wotherspoon et al. compared carbon pools and net carbon flux among five tree species. They found that hybrid poplar, although containing more carbon than the other species because of its fast, early growth, was assimilating carbon at a slower rate, after 25 years, than the other species. Because significant carbon pools are found in the roots, Jefferies et al. used X-ray computed micro-tomography to analyze soil structure in the same alley crop system. This methodology shows promise for studying belowground effects of agroforestry in a non-destructive, non-invasive way. However, the expense and labour required for this method were reportedly prohibitive for routine testing. Another non-invasive way of determining belowground properties was studied at the same site by Borden et al., who used ground-penetrating radar to

quantify coarse roots in the most shallow soil layer as a way of measuring belowground carbon. They found significant differences among five tree species and calibrated these results with destructive sampling in the same test plots.

In an alley cropping system in southern Quebec, Bouttier et al. compared the root distribution of hybrid poplar and red oak, finding that the hybrid poplar had far more roots than the red oak but that they were relatively shallow, with more than 95 % of fine roots occurring in the top 25 cm, while the fine roots of the red oak were more homogeneously distributed to a depth of 45 cm. In the poplar alley crop sites, fine roots of an adjacent hay crop was much reduced, which the authors attributed partly due to root competition with the trees but, to a greater degree, to shading by the trees. At the same site, Doblas-Miranda et al. studied soil mites as an indicator of soil ecological health, comparing mite distribution under poplars and red oaks. Mites were strongly associated with tree fine root biomass, so the fine roots of poplar, which were shallower but of greater quantity than those of the red oak, correlated with high abundance of mites in the more shallow soil layer, while the mites under red oak trees were less abundant and more homogeneous through the soil profile. Alam et al. estimated the economic value of this same alley cropping system, considering ten ecosystem services, including market (agricultural and forestry products) and non-market values. Although agricultural production was the most valuable single service, it was responsible for only one third of the total value, while water, air and soil quality and climate regulation followed it in importance. Since the latter were non-market services benefitting all of society and not the farmers directly, the authors concluded that government incentives to increase adoption of alley cropping were needed and justifiable.

Conclusion

The papers published in this Special Issue show that appropriate agroforestry measures provide important social, environmental and economic benefits in landscapes throughout North America. Of particular interest are papers that address the special conference themes of greenhouse gases, since the emission of greenhouse gas in agroforestry systems, compared to other land use practices, is currently an important area of temperate agroforestry research. On-going research in North America and Europe will result in future published papers addressing this issue. Poplars and willows are of continuing special interest in temperate agroforestry as the fastest growing tree species in much of North America, making them of use to rapidly sequester carbon, to provide shelter, to provide biomass as a form of renewable bioenergy and to produce wood and fibre. Maintaining connections between AFTA and the PCC and the US Poplar Council continue to be fruitful research avenues. Other papers in this Special Issue that address a variety of agroforestry topics—the production of fruits and nuts, the interactions in alley cropping systems and the socioeconomic aspects of agroforestry—ensure that temperate agroforestry in North America continues to be considered as a multi-functional and diverse discipline that encourages the consideration of agricultural land at a landscape scale. The Guest Editors take great pride in helping to create this Special Issue and sincerely hope that readers will find the papers interesting and informative.

Dedication The end of a landmark agroforestry program in the Canadian Prairies occurred in 2013. The Government of Canada, after more than a century of providing adapted and hardy tree and shrub seedlings to prairie farmers, discontinued the Prairie Shelterbelt Program that began in 1901, expressing confidence that agricultural landowners would continue to establish shelterbelts by accessing planting stock from other sources. Rapid agricultural settlement of the Canadian prairies in the late 1800s, and the resulting conversion from native grassland to cropland, dramatically altered the ecology of the Canadian prairie landscape. Because of the frequency of dust storms and snow storms, early prairie settlers began to plant trees, grateful for adapted seedlings provided by the Government of Canada through its tree nursery at Indian Head, Saskatchewan. Over 600 million tree and shrub seedlings were distributed under the program, which became part of the very fabric of western Canadian agriculture, with most farm families accessing the program. This Special Issue is dedicated to the agroforesters, nursery workers and researchers that, over 113 years, contributed to the success of this program that dramatically transformed the western Canadian landscape.

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