COMBINING ORNAMENTAL TREE AND FORAGE CROP PRODUCTION USING BOTH FIELD EXPERIMENTS AND MODELLING APPROACH IN THE NETHERLANDS

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Abstract

As a result of a growing need for sustainable agriculture, a silvopastoral agroforestry system combining ornamental trees and forage grass was established in North Brabant, the Netherlands. While the potential of increased benefits is present for this combined system over traditional cultivation, the use of ornamental trees in agroforestry systems is novel and research on its effectiveness is therefore required. The objective of this study was to compare this agroforestry system with current intensive crop cultivation in terms of yield, economic viability, and environmental impact. Research consisted of (1) a field experiment comparing single and double tree rows for two ornamental trees in an alley-cropping setup and (2) modelling using Yield-SAFE to determine potential yield outputs. As the field experiment is currently in progress, only the yield-SAFE results are discussed. Increased awareness of issues with the application of ornamental trees could improve general application of agroforestry in agriculture.

Keywords: ornamental trees; forage grass, yield-SAFE, silvopastoral

Introduction

Agroforestry can provide both economic and ecological benefits as a result of interactions among its components. These include higher productivity through complementary nutrient use, enhanced soil quality, pest and disease control, and increased biodiversity. Silvopastoral agroforestry, which combines tree production with pasture and frequently includes foraging animals, is one of the most popular systems in Europe (Mosquera-Losada et al. 2012; den Herder et al. 2017). Trees in these systems are often used for acquiring fruit, timber, or fodder for animals.

In North Brabant, the Netherlands, cultivation of ornamental trees for planting in communal areas is a major contributor to the local economy. However, several developments have led to a less favourable market, such as rising land costs and decreasing profits from grown trees. Furthermore, high use of pesticides and nitrate leaching degrade the environment, which [illegible] home to dairy farmers, a silvopastoral agroforestry system combining ornamental trees and forage grass is explored in order to utilize the available land more efficiently and mitigate current shortage of agricultural lands.

This combined cultivation could potentially create benefits in terms of production and environmental impact not present in current monocultural systems. However, the use of ornamental trees in an agroforestry system is novel, and certain aspects of ornamental tree cultivation may cause difficulties. For instance, the production cycle of these trees is much shorter than trees in other agroforestry systems, ranging from four to six years. Additionally, ornamental trees are harvested as a whole, including the roots (Kees van Iersel, personal communication, December 4, 2017). Research on the effectiveness of agroforestry systems including ornamental trees is therefore necessary.

The objective of this study was to compare a novel agroforestry system combining the production of ornamental trees with forage grass with current intensive crop cultivation. Different setups for the agroforestry system were explored, including variable tree density and tree species. Product yields, economic viability, and environmental impacts were compared between these systems. Research is twofold: one field experiment which was established in April 2018 for a duration of three years, and a modelling section with use of Yield-SAFE to determine potential yield outputs of the system's components.

Materials and methods

Field experiment

The field experiment started in April 2018. The elm cultivar 'Columella' (*Ulmus* 'Columella') and honey locust cultivar 'Skyline' (*Gleditsia triacanthos* 'Skyline') were selected for their tolerance for pests and wind, deep root development and small crown for minimizing tree-grass competition, and marketability (Hiemstra 2012; Boomkwekerij Udenhout 2016; Van Den Berk Boomkwekerijen 2018). Perennial ryegrass was selected as crop species for its high quality and palatability as pasture grass (Smit 2005). The field experiment was designed in agreement with participating stakeholders as well as using established literature of optimal agroforestry design. The resulting experimental design will be comparing single and double tree rows for the two different tree species in an alley-cropping setup.

Tree, grass, and soil characteristics are to be measured, as well as interactions between these components. Tree characteristics include trunk circumference, tree height, diameter at breast height (dbh), crown spread and density, branching height, and pest abundance. For grass these are yield and nutritional composition. Soil measurements include dry matter, soil organic matter, soil nutrient content, and nitrogen level. Interactions are measured by light and water competition, and root distribution. Additional measurements are time management and a cost-benefit analysis.

Modelling with Yield-SAFE

The parameter-sparse model Yield-SAFE (van der Werf et al. 2007) was chosen as an accessible method for obtaining yields using climate and soil data. The updated version of Yield-SAFE as part of the AGFORWARD project will be used as this version allows modelling of grasses (Palma et al. 2016). Yield-SAFE was used to model and predict the performance of the different systems in terms of yield, profit, nutrient balance, and make long term predictions of system development.

The model predictions will be compared to data acquired from field experiments. As the field experiment has only started and no results are yet available, only the results of the Yield-SAFE model will be discussed.

Future prospects

Currently, no results can be presented yet. In the current research we are starting to address the lack of research and information on the application of agroforestry in the ornamental tree production sector, and aim to assist the transitioning of current ornamental tree farms into agroforestry systems. Whereas some of the issues are very similar to other agroforestry systems, in this system we also face a number of different challenges and opportunities, for example issues in relation to pest control in trees and the harvesting of tree roots. Increased awareness and knowledge on these issues may also inform the development of agroforestry systems in general.

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