



RELATÓRIO DE ATIVIDADES

1 – DADOS CADASTRAIS

1.1 Nome do Beneficiário José Miguel Reichert	1.2 CPF / Passaporte 356.194.570-87
1.3 Instituição Universidade Federal de Santa Maria	1.3 Programa CAPES/ nº do AUXPE PrInt / 88887.364873/2019-00 Edital 41/2017
1.5 Projeto Solos - Produção e preservação do ambiente	1.6 Coordenador Projeto Dalvan José Reinert
1.7 Programa de Pós-Graduação Ciência do Solo	

2 – BENEFÍCIO

2.1 Modalidade () Missão de Trabalho (x) Bolsa: PVE Sênior		
2.2 Instituição de Destino Texas A&M University Departamentos Ecosystem Sciences and Management e Soil and Crop Sciences	2.3 Período da Atividade	
	2.3.1 Início 09/10/2019	2.3.2 Término 28/09/2020

3 – RECURSOS RECEBIDOS (R\$)

3.1 Auxílio-deslocamento	Passagens pagas diretamente pela Capes
3.2 Auxílio-instalação	US\$ 2.300,00
3.3 Seguro-saúde	US\$ 1.080,00
3.4 Adicional-localidade	-
3.5 Mensalidade	US\$ 2.300,00 x 12 meses
3.6 Auxílio-diário	-

4 – DESCRIÇÃO DAS ATIVIDADES

4.1 Objetivos da missão: (estabelecer correlação com os objetivos do projeto)

O tema água (hidrologia) e estrutura do solo em agrossistemas, objeto da minha proposta PVE, envolveu questões básicas para a compreensão de processos e funcionalidade do solo em sistemas. Portanto, houve um alinhamento singular entre a presente proposta de PVE e o projeto Capes PrInt. Certamente, contribuirá para catalisar o processo de internacionalização, possibilitando avanços nesse tema de pesquisa (água e solo) de significativa relevância econômica e ambiental para o Brasil. O pós-doutorado (PVE Sênior) teve como objetivos:

- a) elaboração e publicação de trabalhos científicos no tema hidrologia do solo e em pequenas bacias hidrográficas, usando dados de experimentos do grupo de pesquisa e revisão bibliográfica;
- b) elaboração e publicação de um artigo dos padrões, impacto e internacionalização da produção científica de pesquisadores de Agronomia/Solos no Brasil, utilizando uma base de dados do CNPq;
- c) análise de imagens tomográficas 3-D de amostras de experimentos em agrossistemas;
- d) contribuição para a manutenção do conceito 6 ou aumento para 7 do PPGCS, perante a Capes.

4.2 Atividades Realizadas:

Elaboração de oito artigos científicos com dados originais, um artigo de revisão e um com a análise do perfil dos pesquisadores PQ-CNPq na Agronomia. Destes, três já foram publicados (vide anexo), seis foram submetidos a revistas e estão em processo de revisão, e seis estão em fase final de elaboração para submissão em breve. Não foi possível trabalhar com o software Avizo (objetivo c), pois não conseguimos comprá-lo, por razões de aumento do câmbio em 2020, e assim não houve o treinamento previsto na empresa em Houston-TX. Tampouco havia disponibilidade do software na TAMU e a possibilidade de usá-lo noutra universidade ficou comprometida pelo fechamento das universidades frente à pandemia do Covid. Não obstante, no regresso ao Brasil, buscarei uma opção alternativa de software de processamento de imagens que consiga atender às necessidades do grupo de pesquisa.

4.3 Resultados e/ou Impactos:

Resultados já alcançados são:

- a) formatação de quatorze artigos científicos, com os resultados de pesquisa obtidos nos últimos anos pelo nosso grupo na UFSM, para submissão a periódicos internacionais. As revistas são Soil and Tillage Research; Canadian Journal of Forest Research; Hydrological Processes; Agricultural Systems; Catena; Geoderma Regional; e International Soil and Water Conservation Research.
- b) formatação de um artigo usando o banco dos bolsistas de produtividade em pesquisa do CNPq, na área da Agronomia, estabelecendo o perfil de seus pesquisadores, com análises quantitativas entre índices de qualidade de produção e internacionalização com nível da bolsa;
- c) apropriação de aspectos positivos relativos a boas práticas científicas e acadêmicas, com vistas à qualificação continuada dos trabalhos de pesquisa do nosso grupo de pesquisa.

Impactos potenciais são:

- a) contribuição para a manutenção/progressão de nível do PPGCS na avaliação da Capes, por meio das publicações a serem geradas na colaboração internacional estabelecida;
- b) melhoria da qualidade das disciplinas na área da física do solo, oferecidas pelo Departamento de Solos.

Santa Maria, 27 de novembro de 2020.



ANEXOS

Artigos já publicados

1. **Reichert, J.M.**, da Silva, V.R., Awe, G.O., Wendroth, O.O., **Srinivasan, R.** 2020. Defining tillage need for edible bean production under no-tillage: Classical and time series analyses. *Soil & Tillage Research*, 202:10467. <https://doi.org/10.1016/J.STILL.2020.104671>
2. Ferreto, D.O.C., **Reichert, J.M.**, Lopes Cavalcante, R.B., **Srinivasan, R.** 2020. Water budget fluxes in catchments under grassland and *Eucalyptus* plantations of different ages. *Canadian Journal of Forest Research* 2020: e-First. <https://doi.org/cjfr-2020-0156>.
3. Ebling, E.D., **Reichert, J.M.**, Peláez, J.J.Z., Rodrigues, M.F., Valente, M.L., Cavalcante, R.B.L., Reggiani, P., **Srinivasan, R.** 2020. Event-based hydrology and sedimentation in paired watersheds under commercial eucalyptus and grasslands in the Brazilian Pampa biome. *International Soil and Water Conservation Research*, <https://doi.org/10.1016/j.iswcr.2020.10.008>.

APÊNDICE TÉCNICO

Face às restrições decorrentes da pandemia Covid, as atividades foram majoritariamente à distância, com troca de e-mails com o prof. Raghavan Srinivasan, da TAMU. Para otimizar a apresentação dos resultados, optei por apresentar destaques (resumos) dos distintos artigos científicos publicados, submetidos ou em finalização/submissão.

Soil & Tillage Research
Journal homepage: <http://www.elsevier.com>

Defining tillage need for edible bean production under no-tillage: Classical and time series analyses

J.M. Reichert^a, V.R. da Silva^b, G.O. Awe^{b,c}, O.O. Wendroth^d, R. Srinivasan^d

ARTICLE INFO

Keywords: Edible bean production; Soil conservation; Soil compaction; Cover tillage; Water usage; Water flow analysis.

ABSTRACT

Mechanical soil conservation techniques are used to keep soils till conserved soils to improve soil structure and increase crop yield. The objective of this study was to investigate the effect of ploughing and chiseling on changes in soil physical properties, quality, the number of days that the soil moisture is outside the critical limits of the total limiting water range, tillage tillage performance, and other soil health tillage method using classical and digital statistical methods. Tillage performance of continuous no-tillage for 5 years (NT), tillage plough (Pl) and chiseling (Ch) tillage soil performance under no-tillage for 5 years. High degree of compaction and low soil limiting water range on the no-tillage area were observed. No-tillage justified the need for evaluating tilling and no-tillage tillage soil conservation techniques. Soil bulk density, soil compaction, and soil moisture content were measured at different layers and soil layers showing bean growth and development, and correlated with total limiting water range. Soil moisture content and temperature data were subjected to statistical analysis. Low penetration resistance was observed in the 0-15 cm soil layer, which was greater in NT than in Pl or Ch soil. In all layers below 15 cm, during the cropping season, spatial variation in penetration resistance was lower in the deep soil layers compared to the surface layers, following the trend on lower resistance in soil layers. Soil bulk density at 0-15 cm depth decreased due to soil disturbance 1.72, 1.65 and 1.52 Mg m⁻³ for NT, Pl and Ch, respectively, and increased with soil depth. The number of days the soil was in good moisture conditions had the order Pl > Ch > NT. Although no-tillage soil is near the critical moisture condition in crop-planted tillage improves soil quality, tillage does not guarantee increased crop yield. The diagnostic crop-penalty and the best limiting water range do not explain soil physical quality for bean growth and yield, soil tillage tillage the antecedent and crop conditions of soil water content in all soil layers. The correlation of soil water content using time series analysis was affected by soil management, with the best performance from Ch tillage. Significant temporal relations were observed between soil water content and other soil attributes, namely, high rainfall being the highest controlling factor. The time series analysis can be combined with classical statistical statistics, for assessing soil quality under different management based on local environmental pattern and climate conditions.

1. Introduction

Edible beans are grown in over 23 million hectares around the world, Brazil is the largest producer (3.6 million tons) with high per capita consumption (1.0 kg edible bean ha⁻¹ yr⁻¹) (CORREIA, 2013), with an average yield of about 3 ton ha⁻¹, although yields above 3 ton ha⁻¹ can be achieved in irrigated crops and with high technological level of production. Edible beans have their growth and yield drastically affected by climatic variations, light sensitivity, and soil water stress during the growing season. In southern Brazil, the bean growing cycle is about 90 days, demands 3000 mm of water and requires high-fertility soil (CEPIS, 2000). Soil physical and chemical conditions also indirectly affect bean growth by affecting rhizobial efficiency in nitrogen fixation (SANTOS et al., 2016; MONTENEGRO et al., 2017).

Intense traffic of agricultural machinery in no-tillage systems lacking crop rotation and cover crops increase soil bulk density and penetration resistance (LIMA et al., 2010), which reduce root growth of black beans (SANTOS et al., 2009) and limit air and water flow and crop access to water stored in soil (SANTOS et al., 2016; REICHERT

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2 **Water budget fluxes in catchments under grassland and Eucalyptus plantations of**

3 **different ages**

4

5 Décio Oscar Cardoso Ferreto^a, José Miguel Reichert^{a*},

6 Rosane Barbosa Lopes Cavalcante^b, Raghavan Srinivasan^c

7

8 ^a Soils Department, Federal University of Santa Maria (UFSM), Avenida Roraima 1000, Santa

9 Maria-RS 97105-900, Brazil.

10 ^b Instituto Tecnológico Vale, Rua Boaventura da Silva, 955, Belém-PA 66055-090, Brazil.

11 ^c Department of Ecology and Conservation Biology, Texas A&M University (TAMU), 534 John

12 Kimbrough Blvd., Room 305, College Station-TX 77843-2120, USA.

13

14 * Corresponding author

15 E-mail: reichert@ufsm.br

16 Phone: +55 55 99705-7652

17

18 Address:

19 Departamento de Solos - UFSM

20 Avenida Roraima 1000

Bairro Camobi

Santa Maria, RS, 97105-900

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Event-based hydrology and sedimentation in paired watersheds under commercial eucalyptus and grasslands in the Brazilian pampa biome

Éderson Diniz Ebling, José Miguel Reichert, Jhon Jairo Zuluaga Peláez, Miriam Fernanda Rodrigues, ... Raghavan Srinivasan

In Press, Journal Pre-proof, Available online 1 November 2020

Download PDF Article preview ^

Abstract Graphical abstract

Abstract

Ecological and hydrological impacts are expected when watersheds are under commercial eucalyptus. In this study we evaluated event-based hydrology and sedimentation in paired watersheds under commercial eucalyptus and grasslands cover. Flow, suspended sediment concentration, and sediment production were measured and simulated with the Limburg Soil Erosion Model (LISEM) in paired hydrographic watersheds located in southern Brazil; one occupied with 7-years old *Eucalyptus saligna* plantation (forest watershed-FW; 0.83 km²) and another Pampa biome (Southern Grasslands) with native and exotic grasses used for beef cattle production (grass

ARTIGOS SUBMETIDOS (alguns já revisados uma vez)

Rainfall partitioning in young clonal plantations *Eucalyptus* species in subtropical environment, and implications for water and forest management

Décio Oscar Cardoso Ferreto^a, José Miguel Reichert^{a*},
Rosane Barbosa Lopes Cavalcante^b, Raghavan Srinivasan^c

^a Soils Department, Universidade Federal de Santa Maria (UFSM), Avenida Roraima 1000, Santa Maria, RS, Brazil.

^b Instituto Tecnológico Vale. Rua Boaventura da Silva, 955, Umarizal, Belém, PA, Brazil.

^c Department of Ecology and Conservation Biology, Texas A&M University (TAMU), 534 John Kimbrough Blvd., Room 305, College Station, TX, USA.

* Corresponding author, E-mail: reichert@ufsm.br, Phone: +55 55 99705-7652

Abstract

Different canopy characteristics of industrial eucalyptus may lead to differences in the amounts of water evaporation and availability to plants. This study aims to contribute to the understanding of rainfall partitioning in young clonal plantation (age of 2 to 4.5 years) of three eucalyptus species as related the tree parameters diameter at breast height, total height, and leaf area index. We measured rainfall, throughfall, stemflow and litter interception, along with the tree parameters. For the three species, rainfall interception varied between 12 and 48%, throughfall between 43 and 90%, and stemflow between 0.3 and 5.4%. The coefficient of determination between interception and rainfall was 0.76, indicating interception depends on other variables, possibly including antecedent rainfall, rainfall intensity, and seasonality. Interception decreased with reduction in leaf area index caused by eucalyptus defoliation. The *E. benthamii* had 0.757 mm of throughfall per 1 mm of rainfall, whereas *E. dunnii* and *E. benthamii* these ratios were 0.716 and 0.678, respectively. High variation in leaf area in *E. dunnii* was associated with greatest amplitude in throughfall (42.8 to 85.9% of the rainfall). Stemflow in *E. benthamii* and *E. dunnii* had higher positive correlation with diameter at breast height of the trees, whereas in *E. saligna* the highest relation was with rainfall. These results contribute to establishing management strategies, such as choosing the most-fit eucalyptus species to local climate, to improve the synchronization of crop-demand versus soil-water-supply while maintaining streamflow to fulfill ecological and production needs.

Keywords: Water balance; Blue-green water; Forest hydrology; Rainfall interception; Rainfall throughfall.

Compaction states and physical environment in three soils for commercial forest production in subtropical Brazil, with application in soil tillage recommendation

José Miguel Reichert^{a*}, Cedinarra Arruda Santana Morales^a, Franciele de Bastos^a,
Jean Alberto Sampietro^b, Jean Pierre Cavalli^a, Elias Frank de Araújo^c, Raghavan Srinivasan^d

^a Soils Department, Universidade Federal de Santa Maria (UFSM), 97105-440 Santa Maria-RS, Brazil

^b Forest Engineering Department, Universidade do Estado de Santa Catarina (UDESC), 88520-000 Lages-SC, Brazil

^c CMPC Celulose Riograndense, 92500-000 Guaíba-RS, Brazil

^d Department of Ecology and Conservation Biology, Texas A&M University (TAMU), College Station-TX, USA

* Corresponding author: J. M. Reichert (reichert@ufsm.br), Tel: +55 55 32208918

Abstract

Intense forestry mechanization may cause soil structure degradation and increase physical impediment to root growth and reduced forest yield, yet little is known on using penetrability as an estimator of soil physical environment by composition properties. Our aim was to investigate the spatial variability of field-measured penetration resistance (PR) and determine the relationships between penetrability and mechanical and hydrologic properties of Planosol, Nitisol, and Regosol used for eucalyptus production. Low, intermediate, and high compaction states were defined according to field PR, and determined bulk density, degree-of-compactness, macroporosity, water retention and availability, and least limiting water range. Field-measured PR, a functional property and a surrogate for resistance to root growth and development, was highly correlated with bulk density independent of soil type. With macroporosity, water retention and availability to plants, correlation with PR did not show an evident pattern for soil types, being smaller or not significant in some cases. Different compaction states, defined by PR, represented diverse magnitudes of degree-of-compactness and least limiting water range conditions more clearly in Planosol and Regosol than for Nitisol. In conclusion, mapping of soil compaction states based on PR data can be used for best management practices and tillage recommendation for forest installation.

Keywords: penetration resistance; composition and functional properties; land use changes; commercial forestry; grasslands biome; MULTIPLE SOIL CLASSES

Rainfall event-based surface runoff and erosion in small watersheds under dairy and direct-seeding grain production

Éderson Diniz Ebling^{1a}, José Miguel Reichert^{a*1b}, Jean Paolo Gomes Minella^{1c},
Doerthe Holthusen^{1d}, Tiago Broetto^{1e}, Raghavan Srinivasan^{2f}

^a ederdinize@gmail.com; ^b reichert@ufsm.br; ^c jminella@gmail.com;

^d doerthe.holthusen@web.de; ^e tiagobroetto@gmail.com; ^f r-srinivasan@tamu.edu

¹ Soils Department, Universidade Federal de Santa Maria (UFSM), Avenida Roraima, 1000, Santa Maria, RS, 97105-900, Brazil.

² Department of Ecology and Conservation Biology, Texas A&M University (TAMU), 534 John Kimbrough Blvd., Room 305, College Station, TX 77843-2120, USA.

*Corresponding author: J. M. Reichert, Email: reichert@ufsm.br

Abstract

Dairy and grain production systems in highly-weathered clayey soils potentially cause silting and pollution of water reservoirs. A 4-years study on erosion and streamflow was conducted in two paired watersheds, similar in terms of land use and soil management but different in size and riparian vegetation, which drain into a reservoir used for drinking water and power generation. We monitored stream discharge and sedimentation to assess the impact of land use and management on runoff and soil erosion during rain events, and calibrated and validated a hydrological model (LISEM). The studied rainfall events, in both watersheds and calibration/validation steps, had a wide range in total rainfall (169.0 - 10.3 mm), rainfall intensity in 1 hour (65.8 - 2.9 mm h⁻¹), stream peak flows (5740.7 - 4.0 L s⁻¹), runoff volume (28868.4 - 12.1 m³), runoff coefficient (31.5 - 0.1), maximum suspended sediment concentration (19610.8 - 20.3 mg L⁻¹), and sediment yield (33.790 - 0.002 Mg km⁻²). Both watersheds showed rapid responses to rain events with significant runoff, indicating high risk of displacement of manure residues to the drainage network and, finally, to the water reservoir. The abundance of roads (often parallel to the slope) promoted high water losses due to canalization effect. Greater (59%) abundance of riparian vegetation was not effective in reducing runoff and erosion. Furthermore, the local adoption of no-tillage is insufficient to control runoff. The LISEM calibration and validation steps showed satisfactory results (NSE > 50) for hydrological and erosive behavior, and can be used to represent effects of rain events of different magnitudes. These results emphasize the need of further developing and implementing conservation strategies to mitigate pollution and silting up of regionally important water reservoirs.

Key words: stream discharge, hydrograms, sediment yield, siltation, LISEM model

Afforestation of degraded grasslands reduces erosion and may contribute to streamflow regulation in small catchments in short-run

Mirian Lago Valente; Universidade Federal de Santa Maria, Santa Maria, RS, Brazil.

*José Miguel Reichert; Universidade Federal de Santa Maria, Santa Maria, RS, Brazil.

Rosane Barbosa Lopes Cavalcante; Instituto Tecnológico Vale - Desenvolvimento Sustentável, Belém, PA, Brazil.

Jean Paolo Gomes Minella; Universidade Federal de Santa Maria, Santa Maria, RS, Brazil

Olivier Evrard; Laboratoire des Sciences du Climat et de l'Environnement (LSCE/IPSL), UMR 8212 (CEA/CNRS/UVSQ), Université Paris-Saclay, Gif-sur-Yvette, France.

Raghavan Srinivasan; Department of Ecology and Conservation Biology, Texas A&M University, College Station, TX, USA.

*Corresponding author:

E-mail: reichert@ufsm.br Tel: +55 55 32208918 Fax: +55 55 32208295

Mail address: Soils Department, Federal University of Santa Maria, Avenida Roraima, 1000, Bairro Camobi, Santa Maria-RS 97105-900, Brazil.

Abstract

Land use change in the Southern Grasslands biome with the introduction of exotic, fast-growing forest species is a controversial topic, because of the potential effect on water and soil resources. The aim of this study was to assess the effects of afforesting degraded grassland on streamflow and sedimentation in subtropical headwater catchments. Two small, headwater catchments were studied, one planted with *Eucalyptus saligna* (EC: 0.83 km²) and the other with grasslands and extensive livestock (GC: 1.10 km²). Rainfall, runoff, and sediment discharge were monitored from Sep. 2013 to Mar. 2017. The results show two-fold higher surface runoff and sediment yield occurred in GC than in EC. Maximum and mean runoff coefficients were, respectively, 45.5 and 10.2% in GC, and 12.4 and 2.2% in EC; suspended sediment yield was, respectively, 67.9 and 22.4 Mg km⁻² in GC and EC; and bed load sediment yield was only 0.053 and 0.006 Mg km⁻² ha⁻¹. *El Niño* year high rainfall produced the highest annual sediment yield, with values 4.2 times greater in GC (167.7 Mg km⁻²) than in EC (39.9 Mg km⁻²). Hydrographs/sedimentographs synchronization and hysteresis patterns suggest faster sediment delivery in GC than in EC, but further studies are needed to conciliate sediment sources results with sediment fingerprinting. Staggered forest harvest (21% of the planted eucalyptus) led to sediment yield comparable to the observed during the pre-harvest period, and lower than in grassland catchment. In conclusion, well-managed forest plantations, including staggered forest harvesting and preservation of riparian forest, are less prone to erosion than degraded grassland under intensive grazing. Thus, well-managed afforestation of degraded lands contributes to soil conservation in the studied region. Moreover, the low ecological performance of the degraded grassland catchment calls for soil and pasture management practices to increase forage offer to grazing animals, while conserving soil and water resources.

Keywords: Forest hydrology; land use change; runoff; erosion; sediment yield.

Best tillage practices for early-growth of clonal eucalyptus in soils with distinct granulometry, drainage and profile depth

José Miguel Reichert^{1*}, Cedinara Arruda Santana Morales¹, Edberto Moura Lima¹, Franciele de Bastos², Jean Alberto Sampietro², Elias Frank de Araújo³, Raghavan Srinivasan⁴

¹ Soils Department, Universidade Federal de Santa Maria. Av. Roraima, 1000, CEP: 97105-900, Santa Maria, RS, Brazil.

² Forest Engineering Department, Universidade do Estado de Santa Catarina (UDESC), 88520-000 Lages-SC, Brazil

³ CMPC Celulose Riograndense, Rua São Geraldo, 1680, Guaíba, RS 92500-000, Brazil.

⁴ Department of Ecology and Conservation Biology, Texas A&M University (TAMU). 77843-2120 College Station-TX, USA.

*Corresponding author: reichert@ufsm.br

Abstract

Soil tillage influences early-growth, uniformity, and productivity of commercial forests. Best tillage practices for soils with drainage and effective-depth constraints are widely unknown for subtropical forest plantations in South America. We evaluated best tillage practices for early-growth parameters of clonal *Eucalyptus saligna* (up to 24 months of age) in southern Brazil. The tillage methods consisted of subsoiling to 50 cm plus rototilling, subsoiling to 50 cm plus ridging, and subsoiling to 70 cm plus rototilling. The soils were low-drainage Planosol, shallow sandy Regosol, and compacted clayey well-drained Nitisol. The dendrometric evaluations for initial growth show the best tillage method depended on soil type and dendrometric parameter. Tree height is maximized by deep subsoiling (70 cm) in Nitisol, and by shallow subsoiling (50 cm) plus ridging in Regosol and Planosol. Tree diameter at breast height and basal area were maximized by shallow subsoiling with or without ridging in Planosol, deep subsoiling in Nitisol, and shallow subsoiling with ridging or with deep subsoiling in Regosol. When considering all the studied dendrometric variables (tree height, diameter at breast height, and basal area), subsoiling plus ridging is recommend for low-drainage or shallow soils, whereas deep-subsoiling is essential in clay soils.

Keywords: forest soils; deep tillage; subsoiling; forest productivity; sustainable forestry

Experimental catchments in the Pampa biome: Database on hydrology in native grasslands and eucalyptus plantations in subtropical Brazil

José Miguel Reichert^{1*}, José Carlos de Deus Junior², Norton Borges Junior², Rosane Barbosa Lopes Cavalcante³

¹ Soils Department, Universidade Federal de Santa Maria. Santa Maria-RS, Brazil. E-mail: reichert@ufsm.br (*corresponding author)

² CMPC Celulose Riograndense. Guaíba-RS, Brazil.

³ Instituto Tecnológico Vale. Belém-PA, Brazil.

Abstract

The introduction of exotic, fast-growing forest species in the Pampa biome (Southern Grasslands) is a controversial topic, including the potential effect on water and soil resources. This repository contains hydrologic data (discharge and erosion) collected in small, paired experimental catchments of the "Ponta da Canas" site, in the Pampa biome in subtropical Brazil. Three catchments are monitored since 2011, two predominantly covered with eucalyptus and one with livestock-grazing grassland. The data include rainfall, stream depth, and stream turbidity for each catchment, automatically recorded in 10-min intervals. In each catchment, rainfall is measured with an automatic tipping-bucket rain gage; stream depth is determined with a pressure transducer at the spillway, and a rating curve is used to calculate the stream discharge; and turbidity is measured with a turbidimeter. Besides being used to understand water balance and erosion under the distinct catchment uses and to improve forest management, the State environmental agency requires streamflow monitoring to fulfill the requirements for the Environmental Zoning of the Forestry Activity.

Keywords: Forest/grassland hydrology; green-blue water; forest management; streamflow; sedimentation.

ARTIGOS EM FINALIZAÇÃO

Pesquisadores e bolsistas PQ-CNPq em Agronomia: gênero, idade científica, produção e impacto científicos, e formação de recursos humanos

José Miguel Reichert¹ & Raghavan Srinivasan²

¹ Professor de Física do Solo, Universidade Federal de Santa Maria, Santa Maria-RS. reichert@ufsm.br

² Department of Ecology and Conservation Biology, Texas A&M University (TAMU). 77843-2120 College Station-TX, USA.

Abstract

A transparência dos critérios de julgamento e o acompanhamento as recomendações das bolsas demandam um olhar crítico e frequente reavaliação dos parâmetros adequados para classificar bolsistas vs. não-bolsistas e categorias/níveis de bolsas de produtividade de pesquisa (PQ) do CNPq. O objetivo deste estudo é informar à comunidade científica e às agências de fomento sobre o perfil dos bolsistas PQ de Agronomia e contribuir para a análise da distribuição das bolsas usando como amostra os postulantes a bolsa na Chamada de 2018. Dados cadastrados no Currículo Lattes foram usados para quantificar o índice de produção científica que considera o número de artigos publicados, com pesos diferentes para distintos segmentos de valores de fator de impacto, além do número de patentes e do número de livros publicados, e o índice formação de recursos humanos que considera o número de orientações e o nível da mesma (iniciação científica, mestrado, doutorado e pós-doutorado) concluídas na condição de orientador principal. Foram considerados também o índice H (base ISI-Web of Science e base Scopus), a idade científica e o índice m, bem como o gênero dos bolsistas. Os resultados mostram que mais de três-terços dos bolsistas PQ de Agronomia é do sexo masculino. Nos níveis da categoria 1 e no próprio comitê da Agronomia, a participação relativa de pesquisadoras é ainda mais reduzida. Há menores chances de sucesso e ascensão na carreira por parte das mulheres, caracterizando um espaço para alcançar a equidade de gênero. Os índices de produção científica, de formação de recursos humanos e de inserção nacional/internacional (índice h) não são homogêneos dentro de um mesmo nível/categoria, apesar da busca de indicadores de avaliação mais transparentes e auditáveis. Se por um lado são absolutamente necessários indicadores objetivos e facilmente calculáveis para um grande número de pesquisadores, a avaliação crítica desses indicadores e a busca de outros devem avançar e estar em sintonia com a avaliação pelos pares.

Onion-forage cropping systems on a vertic Argiudoll in Uruguay: onion yield, and soil organic matter, aggregation, porosity and permeability

José Miguel Reichert^a, Adão Leonel Corcini^a, Dalvan José Reinert^a, Gabriel Oladele Awe^b, Claudio Cesar García Gallarreta^c, Roberto Docampo^c, Raghavan Srinivasan^d

^a Soils Department, Federal University of Santa Maria (UFSM), Santa Maria-RS, Brazil.

^b Soil Resources and Environmental Management Department, Faculty of Agricultural Sciences, Ekiti State University, Ado Ekiti, Nigeria.

^c Estación Experimental "Wilson Ferreira Aldunate"- INIA Las Brujas, Canelones, Uruguay.

^d Department of Ecology and Conservation Biology, Texas A&M University (TAMU). 77843-2120 College Station-TX, USA.

Corresponding author: J. M. Reichert (reichert@ufsm.br), Tel: +55 55 32208918

Abstract

Hostipastoral systems in small farming units that integrate horticulture crops, as main cash crop, with sheep/cattle raising on cultivated forage present physical restraints to crops because of the vertic soils and unique tillage requirements. The objective of this study was to evaluate the effect of different hortipastoral systems on soil organic matter, aggregation, porosity and permeability during a cropping year in onion-forage hortipastoral systems. A long term experiment was installed in 1995 in the National Institute for Agricultural Research (INIA-Las Brujas) in Uruguay, on fine (mixed) smectitic thermic superactive Vertic Argiudolls previously under native grasslands, consisting of cropping systems for onion production, maintained for 3 years and then rotated. Onion yield was evaluated during the period 1998-2006. In the cropping year 2006-2007, corresponding to the end of a 3-year cropping cycle, we evaluated soil organic matter and physical properties and functioning in the cropping systems: alfalfa, fescue, forage consortium (birdfoot trefoil, alfalfa and white clover), onion after alfalfa, onion after fescue, and onion after consortium. In four periods during the cropping year, aggregate stability and organic matter were determined for the 0-0.05 m soil layer, whereas soil density, porosity, and hydraulic conductivity were determined in 0-0.01 and 0.1-0.2 m layers. The results showed high variability in onion yields from 1998 to 2006, mainly related to high rainfall that affected crop planting, growth and development, with better onion yields after alfalfa and fescue. The hortipastoral systems evaluated in this study favor the maintenance of soil organic matter and macroaggregation, but to install the onion crop in the vertic soil tillage is needed. Tilling the soil under forage crops reduces macro and increases microaggregates percentage, but increases macroporosity and functioning in terms of water and air permeability and decreases the degree of compaction. Finally, there is a significant potential of hortipastoral systems and proper management of SOM to minimize adverse effects of climate, and improve productivity stability of intensive production systems. Single forage crops, either legume or grass, are more beneficial to onion yield than consortium of grass plus legumes.

Keywords: hortipastoral systems, conservation agriculture, soil structure, soil tillage, soil functioning.

Water balance and use efficiency in eucalyptus plantations affected by tree stockings in sandy soil during rainy El Niño year

José Miguel Reichert^{1*}, Juliana Prevedello², Paulo Ivonir Gubiani¹, Eduardo Saldanha Vogelmann², Dalvan José Reinert¹, Claudine Ohana Barcellos Consensa¹, Júlio Cesar Wincher Soares³, Raghavan Srinivasan⁴

¹ Soils Department, Universidade Federal de Santa Maria (UFSM). Av. Roraima, 1000, Santa Maria-RS, Brazil. *Corresponding author: reichert@ufsm.br

² Universidade Federal de Rio Grande (FURG), São Lourenço do Sul-RS, Brazil.

³ Universidade Regional Integrada (URI), Santiago-RS, Brazil.

⁴ Department of Ecology and Conservation Biology, Texas A&M University (TAMU), College Station-TX, USA.

Abstract

Eucalyptus tree stocking can be adjusted to increase, depending on purpose, cellulose, timber or bioenergy production, but stocking affect ecosystem water balance. We examined rainfall dynamics in *Eucalyptus dunnii* planted under different stockings to quantify rainfall partitioning, water balance, and water use efficiency in a sandy soil in a rainy El Niño year. Total rainfall, throughfall, stemflow, canopy interception, evapotranspiration, tree growth, and water use efficiency were evaluated over a 1-year study period (5–6 years after planting), in low (816 trees ha⁻¹), medium (1633 trees ha⁻¹), medium-high (3265 trees ha⁻¹), and high tree stockings (6568 trees ha⁻¹). Annual rainfall (P) was 2583 mm, almost double of historical rainfall, while canopy interception (34–37% of P) and effective rainfall (63–66% of P) had no clear relation with tree stocking. Throughfall decreased (62–53% of P) and stemflow increased (2.1–12.7% of P) with increased (low to high) tree stocking. Deep drainage was below 0.16%, thus groundwater recharge is potentially low even with high rainfall, and surface runoff was 5.7% of the rainfall, because of high soil infiltration and low slope. Annual actual evapotranspiration varied from 1304 to 1438 mm (50–56% of P), highest for high tree stocking, whereas daily evapotranspiration rates varied from 0.8–11.7 mm d⁻¹. With increasing tree stocking for *E. dunnii* 5–6 years after planting, individual wood increment varied from 4.9 to 54.8 kg tree⁻¹ and stand wood production varied from 27.1 to 42.2 Mg ha⁻¹ yr⁻¹ for high and low stocking, respectively. Water use efficiency varied from 2.1 to 3.1 g L⁻¹, highest for low stocking. Industrial eucalyptus planted in sandy soils at high stocking for energy production may overuse stored water in years of lower rainfall, as a consequence of high evapotranspiration and low water use efficiency, thus affecting long-term forest sustainability. Studies on soil and catchment hydrology and forest management, encompassing distinct climatic years, are needed for this understudied ecosystem to improve water use efficiency and streamflow regulation, and thus bridging forestry and ecosystem processes.

Keywords: rainfall interception, effective rainfall, actual evapotranspiration, soil moisture, green/blue water.

Rheology and micromechanics of (sub)tropical soils under dynamic stresses – a review

Dörthe HOLTHUSEN^{1*}, Amanda Romeiro ALVES¹, Gabriel Oladele AWE², Alan Carlos BATISTÃO³, Patricia PÉRTILE¹, Douglas Leandro SCHEID¹, Viviane SOBUCKI¹, José Miguel REICHERT¹

¹ Soils Department, Universidade Federal de Santa Maria (UFSM), Santa Maria-RS, Brazil

² Department of Soil Resources and Environmental Management, Faculty of Agricultural Sciences, Ekiti State University, Ado Ekiti, Nigeria

³ Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil

*corresponding author, email: doerthe.holthusen@web.de

Abstract

Stress-strain relationships are a key element of soil physics all over the world. Whenever it comes to the analysis of sustainable soil management, a soil's bearing capacity, shear resistance, pore system, and aggregation intensity are fundamental for both establishing and maintaining a healthy and thus fertile soil with regard to food production and animal husbandry. Small-scaled rheology is applied to simulate the repeated stresses that occur during trafficking but also trampling. While most of the more established methods consider soil at equilibrium and apply a static load, like preconsolidation or precompression tests, dynamic stresses are a situation more likely at field conditions and more appropriate to study a soil's susceptibility towards incoming repeated stresses. Brazilian soils stand out from other soils especially due to their large variety, the climatic peculiarities of the different regions (subtropical and tropical climates) and the local and national agricultural management strategies. Besides, different sociological and environmental demands and regulations form the actual land use distribution and the current soil management. We reviewed the recently investigated rheology of Brazilian soils and shed light on peculiarities, actual strategies and challenges these soils undergo and how rheology can help in characterizing them and improve our understanding of these subtropical and tropical pedosystems with regard to soil physical and physicochemical properties. The summarized findings might be transferred to similar regions with regard to climate, soil types and crop systems, e.g. some Asian or African regions, and further address the impact of repeated stresses by means of soil-tool interactions (vibration), repeated wheeling (multiple axes as well as repeated passes in highly frequented areas) and trampling (in grazed pastures) in general.

Keywords: soil mechanics, rheometry, soil microstructure, soil stress/strain, soil deformation

Soil load bearing capacity and functioning of Oxisol in southern Brazil under no-tillage crop and forest/grassland soil use

José Miguel Reichert^{1*}, Carlos Arnoldo Streck^{1b}, Dalvan José Reinert^{1a}, Milton da Veiga^{1c}, Rainer Horn^{1d}, Raghavan Srinivasan^{1e}

^a Soils Department, Universidade Federal de Santa Maria (UFSM), Santa Maria-RS, Brazil. reichert@ufsm.br

^b Instituto Federal Farroupilha (IFF), São Vicente do Sul-RS, Brazil

^c Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (EPAGRI), Campos Novos-SC, Brazil. Now retired.

^d Kiel University (CAU), Kiel, Germany

^e Texas A&M University (TAMU), College Station-TX, USA

Abstract

Soil compaction is a major constraint to soil quality and crop growth. Our objective was to relate soil basic properties and land use to mechanical and hydraulic behavior of Oxisols. Compressibility, relative soil compaction, porosity, and hydraulic and aeration properties were determined on seven Oxisols located in southern Brazil, in different layers, under no-tillage (NT) crop production for more than 5-years and a non-agriculture condition (either natural forest NF or native grassland NG used for grazing). Particle size distribution, organic carbon and iron oxides were quantified to characterize the studied soils. Soil under NT increased soil bulk density, decreased total porosity and changed the distribution of pore diameter, increasing the proportion of small pores and causing the consequent decrease in water and air permeability. Compaction under NT varied between soils in terms of intensity and position of the compacted layer. In soils under NG, only one clay texture Oxisol did not show compaction caused by animal trampling. Soil compaction increased the proportion intermediate or small of pores in detriment to macropores. Soil preconsolidation stress or load bearing capacity, on wet soil (-6 kPa matric potential) decreased with increased organic, silt content, and total and macroporosity, but no relation when the soil was drier (-30 kPa matric potential). On wet soil, soil with higher load bearing capacity had lower water and air permeability.

Keywords: mechanical properties, soil functioning, water/air permeability, iron oxides.

Growth of *Eucalyptus saligna* and *E. dunnii* in subtropical Brazil: soil and productive capacity classes

José Miguel Reichert^{1*}, Bruno Morales², Edberto Moura Lima¹, Franciele de Bastos¹, Cedinara Arruda Santana Morales³, Elias Frank de Araújo², Raghavan Srinivasan⁴

¹ Soils Department, Universidade Federal de Santa Maria. Av. Roraima, 1000, Santa Maria-RS, Brazil. E-mail: reichert@ufsm.br (*corresponding author)

² CMPC Celulose Riograndense, Rua São Geraldo, 1680, Guaíba-RS, Brazil.

³ Formely with the Programa de Pós-graduação em Engenharia Florestal, Universidade Federal de Santa Maria.

⁴ Texas A&M University (TAMU), College Station-TX, USA

Abstract

The perception of forest fertility has usually been constrained to soil nutrients, with little focus on soil physical and morphological properties and processes. Our hypothesis was that soil physical and morphological properties are more closely related to forest growth than soil chemical fertility. The objective of the study was to analyze the influence of soil properties, in different soil classes, with the productivity and dendrometric variables of clonal *E. saligna* and seminal *E. dunnii*, both widely employed in commercial plantations managed for pulp and lumber production in southern Brazil. On inventory plots with two distinct genetic materials, namely nine soils cropped to *Eucalyptus saligna* and thirteen to seminal *Eucalyptus dunnii*, we evaluated morphological, physical and chemical properties along the soil profiles (Alfisol, Ultisol and Entisol) and dendrometric variables as the dominant height (h_{100}), mean annual increment (MAI), and volume of wood with bark (m³ ha⁻¹) estimated for 7-years age. The results show Alfisols clearly differentiate themselves from the other two soil orders. Overall, Ultisols and Entisols have similar distribution of soil physical and chemical values along the soil profile. Alfisols stand out with highest total porosity, microporosity, water retention at field capacity and permanent wilting point, available water capacity, soil organic matter, pH, exchangeable Ca and Mg, cation exchange capacity at soil pH (effective) and at pH 7 (potential), base saturation, and available Zn and Cu; and lowest sand and highest silt contents and Al saturation. Ultisols have as distinguishing properties highest soil bulk density, degree of compaction and clay content below 50-cm depth; and lowest silt content. Entisols are prominent for their lowest water retention at field capacity and lowest available water capacity. Overall, the DBH ranged from 77.98 to 304.30 cm, with average value of 183.23 cm, but the DBH was not affected by genetic material, soil type and their interaction. Tree height was greater (23.4 m) for *E. saligna* than for *E. dunnii* (22.1 m). Among soil types, Ultisols had the tallest trees (23.5 m), Entisols the shortest (22 m), and Alfisols intermediate (22.6 m). The effect of soil chemical fertility on forest productivity is complex, and the soil physical and chemical properties are poor forecasters of tree productivity.

Keywords: forest management; forest yield; soil physical conditions; soil fertility.

REGISTRO FOTOGRÁFICO

Texas A&M University: em frente ao Laboratório, na baía de trabalho e em reunião com o colaborador prof. Raghavan Srinivasan.

