NEWSLETTER Nº13, July 2024

1. Cropland Research Group GRA Co-Chairs message

The Cropland Research Group of the Global Research Alliance delivers this newsletter to all GRA members to show the CRG progress in reaching their goals. Sustainability is subjacent to the different main topics deployed in this number. One of the news is collaboration of a CRG Co-chair with the FAO to develop a methodology for the agroforestry definition to extent that will allow to monitor at a country level for the FRA Network a system able to combine agriculture products with woody perennials production as a form to mitigate climate change. The agroforestry monitoring is the first essential step for developing agroforestry policy funds and quantifing the impact of these funds at the country level. The project started in June 2024 and will end in 2025. The CRG newsletter also describes the new project SUS-SOIL successfully awarded with 7 million EU Mission Soils funds, includes 24 partners from Europe and Africa. The project starting in October aims at developing a methodology to quantify soil carbon sequestration considering the deeper soil layers' capacity to sequester undisturbed carbon. Soil health specifically tracking soil microbiota which is the main topic of the long-term experiment conducted in a silvopasture system developed under a *Pinus radiata* experiment. The main results imply that external inputs modify microbiota in the soil in the long term.

Two CLIFF-GRADS fellows finished their training under the supervision of the U.S. Co-Lead of the GRA-CRG at the USDA-Columbia Plateau Conservation Research Center in Pendleton, Oregon, and published two manuscripts with collaborators from the University of Nebraska, Haramaya University in Ethobia, and Prince of Songkla University in Thailand. A third CLIFF-GRADS fellow from Tanzania finished her CLIFF-GRADS training on greenhouse gases (CO2, CH4 and N2O) measurements. Feasible and low cost metrics to soil organic carbon quantification in the context of soil carbon global market remains as a challenge. In this NL it is presented a success case demonstrating ability of laser-induced breakdown spectroscopy (LIBS) for quantification of soil C in eleven farms from different Brazilian biomes in an on-farm research project. The main results were published in the Journal Frontiers of Soil Science, last January.

GRA-CRG conducted two webinars during March and June 2024. The next seminar will be in conducted during September.

We wish you an enjoyable reading.

Source: María Rosa Mosquera-Losada (USC, Spain), Ladislau Martin-Neto (EMBRAPA, Brazil), Hero Gollany (USDA, USA).

GRA-CRP AND AGMIP WEBINAR: TWO "Co-benefits and tradeoffs of agricultural mitigation and adaptation in rice based cropping systems". The webinar included presentations from Drs .Roberto Valdivia (Oregon State University, USA), Sonali McDermid (New York University, NASA-GISS, USA), Tao Li (International Rice Research Institute, IRRI, Philippines), and Erik Mencos (Columbia University, NASA-GISS, USA). The recording of the webinar is available at:

https://globalresearchalliance.org/library/croplands-research-group-agmip-webinar/

GRA-CRP Webinar on 26 June, 2024 entitled **"Stacking 4R practices with conservation agriculture to mitigate nitrous oxide emissions".** The webinar included two presentations by Dr. Craig Drury (Agriculture & Agric-Food Canada), and Dr. Diego Abalos (Department of Agroecology, Aarhus University, Denemark). The recording of the webinar is available at:

https://globalresearchalliance.org/library/croplands-research-group-webinar-26-june-2024/

2. World inventory of agroforestry systems

The University of Santiago de Compostela (USC), Spain, and the Food and Agriculture Organization of the United Nations (FAO) will jointly assess the current situation of agroforestry systems at an international level through the design of a work methodology that allows updating the databases of the different national inventories. The work that will be led from the USC by full professor María Rosa Mosquera Losada, coordinator of the Research Group of Agroforestry and Agroecology Systems, is the result of an agreement signed by both institutions with the desire to respond to what was agreed in the 28th Session of the FAO Committee on Agriculture, as well as in the 26th Session of the FAO Committee on Forestry.

Understanding the potential of agroforestry systems is, according to FAO, a fundamental challenge for the coming years to ensure the sustainability of agricultural and forestry systems. However, national inventories may not have adequately calibrated the capacity of their agroforestry systems, a fact that can currently be mitigated through the use of remote sensing and higher resolution satellite images, but also through control over the land, strategies that justify the need for a renewal in the approach of these inventories. In this context, the work that the USC will develop for the FAO until 2025 will allow data to be incorporated into the respective national reports and connect them with the objectives of reducing the emission of greenhouse gases.

As Rosa Mosquera explains, one of the main objectives of this agreement will be to "strengthen existing methodologies to assess the extent of agroforestry practices at local, regional, national and global levels". At the same time, the research will focus on consolidating and complementing the information collected in the Global Forest Resources Assessments (FRA) that FAO has developed since 1946 and which provide essential information to understand the extent of forest resources, their condition, their management and their uses. The FAOSTAT database will also be completed, offering free access to statistics on food and agriculture—including the sub-sectors of crops, livestock and forestry—corresponding to more than 245 countries and territories. In addition, recommendations for agroforestry monitoring and reporting will be provided which will then be fed into databases such as the FRA.

After a systematic review of existing methodologies at an international level, a proposal will be developed to improve monitoring and agroforestry statistics worldwide, in addition to coorganizing and assuming the technical direction of a specialist workshop to validate the proposed recommendations. This will be followed by a pilot experience in geographical locations on several continents where results will be collected and analyzed, which will also be validated in a workshop with specialists. This project phase is fundamental as it will allow "to identify gaps and possible ways forward", concludes Rosa Mosquera.

Figure 1: Some members of the Research Group of Agroforestry and Agroecology Systems (USC) visiting agroforestry systems established in Galicia (NW Spain).

Source: María Rosa Mosquera-Losada (University of Santiago de Compostela, USC, Spain; GRA-CRG Co-Chair).

3. SUS-SOIL project

SUS SOIL

The European project SUS-SOIL "Sustainable soil and subsoil health promotion by implementing agroecological land use and management to enhance ecosystem services delivery for society" funded under the European Soil Mission will be launched in October 2024. SUS-SOIL is coordinated by full professor María Rosa Mosquera-

Losada from the [University of Santiago de Compostela] (NW Spain) and includes 22 partners from 13 countries. SUS-SOIL is a 4-year project adopting a multidisciplinary approach that will develop a set of 15 Subsoil-Living Labs (LLs) to inventory, analyse and benchmark different agroecology subsoil management (ASM) and land uses and their impacts on the subsoil spatial variations and dynamics to best combine ASM practices in rural and urban areas within a global regional context. SUS-SOIL results will be the starting point to increase the awareness of land managers and public authorities to understand the subsoil threats and risks, support EU agroecological transformation by tackling subsoils and improving ecosystem services delivery, promote water security and climate change mitigation of rural and urban ecosystems. The main outcomes include: (1) to develop a subsoil/soil monitoring database (S-DB) able to be interoperable with the LUCAS and ESDAC databases, (ii) the analysis of long-term ASM land use and management of 3 relevant types of soil per LL and the relationship with rural and urban ecosystem services delivery including modelling, (iii) develop a set of farm idiotypes per LL mixing the ASM best practices as an alternative to conventional systems to enhance the ecosystem services provision at regional level for citizens through (iv) a Subsoil Decision Support Tool (S-DST) considering soil degradation and relevant business models and propose a (v) subsoil policy strategy framework to foster ASM best practices.

More information about the SUS-SOIL project will be published in the next issue of this newsletter.

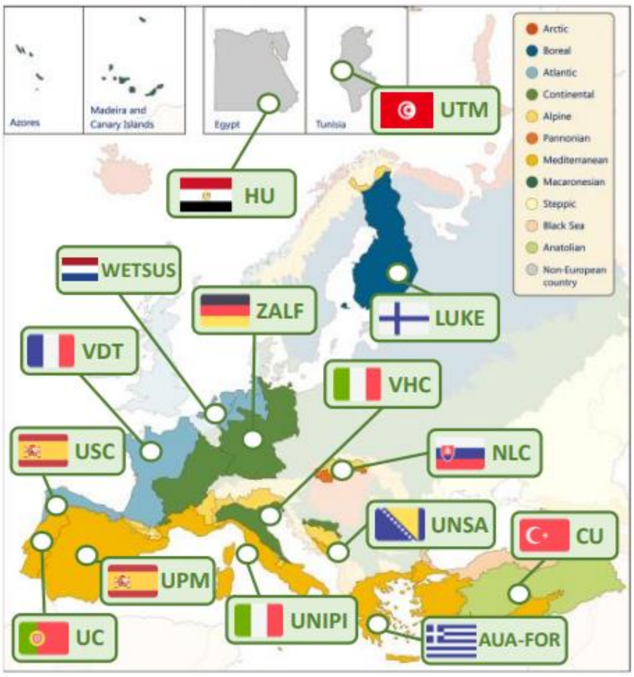

Figure 2: Agroecological Subsoil Management Network (ASMN) and SUS-SOIL living labs.

Source: María Rosa Mosquera-Losada (University of Santiago de Compostela, USC, Spain; GRA-CRG Co-Chair).

4. Effect of past sewage sludge application on bacterial families in an agroforestry system

The importance of soils has been highlighted in Europe through the creation of the soil health and food mission as a way to recognize their important role in human life and as a provider of ecosystem services to clean water, support biodiversity, nutrient cycling and regulate climate change (EC, 2022). Soil microorganisms are the basis for the provision of a large range of ecosystem services associated with nutrient cycling and plant aboveground performance depends on a great extent on extremely complex belowground soil biological networks (Mooshammer et al., 2014; van der Heijden et al., 2008). Although there is a huge amount of available literature on the effects of the long-term application of sewage sludge to soils, studies are usually focused on the short-term after the last application of the amendment. Therefore residual long-term effects are usually under-evaluated. In this study, we investigated the residual effect of sewage sludge addition (alone or in combination with $CaCO_3$) to an agroforestry system (*Pinus radiata* plantation in combination with pasture) in the region of Galicia, located in the NW of the Iberian Peninsula (15 years after the last application of the amendment) on the soil physicochemical properties (including mid-infrared spectral signature of soil organic matter (SOM) and bacterial diversity using a 16s rRNA amplicon sequencing approach.

After 15 years of the last fertilisation application still, some residual effects were observed in the soil chemical parameters (such as pH, exchangeable Na, Ca or K) but also in soil bacterial communities. However, no significant effect of the fertilization was found in the mid-infrared spectral signature of soil organic matter (SOM) and total amount of organic carbon, suggesting that sludge did not affect organic matter (OM) quality measured in the mid IR-region and probably the spectral signature of the OM in these soils is dominated with the accumulation and decomposition of pine needles which homogenizes the type of SOM (up to 5 Mg DM of needles ha^{-1} can be found after 10 years of plantation according to Rigueiro-Rodríguez et al. (2012). Moreover, it is important to highlight, that the initial content of OM in the soils of the present study was already high (between 12- 20% OM according to Cuiña-Cotarelo (2011) which could be also a reason, to explain the lack of effects of sewage sludge 15 years after the treatments.

Although no consistent differences in bacterial richness and diversity were found among treatments, a tendency to decrease biodiversity indexes in fertilized soils was observed. This tendency was corroborated in the number of specific bacteria for each treatment (Figure 3, Venn diagram), where the no fertilised (NF) soils showed the highest number of unique soil families: 11 families were found to be exclusive for the NF treatment and between 0 and 5 exclusive to sewage sludge (SS) or SS_$CaCO_3$ treatments; suggesting a replacement of the low fertility adapted species, within these; members of bacteria involved in N cycling such as Nitrospiraceae and Nitrospinaceae were found as specific of NF soils. N-cycling bacteria have shown to be sensitive to N levels in soils and their presence is favored by the low amount of soil available N (Wang et al., 2019). In the present study, this fact could be due to the establishment in these treated soils of a community of specific bacteria (either applied with the amendment or the promotion of rapidly growing soil-borne bacteria) which can successfully colonise with high growth rates more nutrient.rich environments (such as amended soils). On the other hand, a poor nutrient environment (such as NF soils) would allow the development of a wide range of soil bacteria with different ecological traits adapted to these conditions. Moreover, $CaCO_3$ addition with the SS led also to a reduction of specific bacterial families suggesting a stronger or at least more lasting effect of the combination with $CaCO_3$ treatment. Despite these effects, most bacterial families were present in all soil treatments, indicative of the cosmopolitan character of these communities.

Soil pH and exchangeable Al were the main factors shaping soil bacterial communities. It is important to highlight that although most of pH correlations were negatively affecting soil bacterial abundances, in the case of exchangeable Al (even at the toxic levels that are present) most of the correlations with bacterial abundances were positive. Al is known to be a key factor influencing soil productivity in the region of Galicia, Therefore, further studies on Al tolerant bacteria could be of great interest to support sustainable management practices of these soils.

For detailed information, please see Applied Soil Ecology, 187, Article 104820.

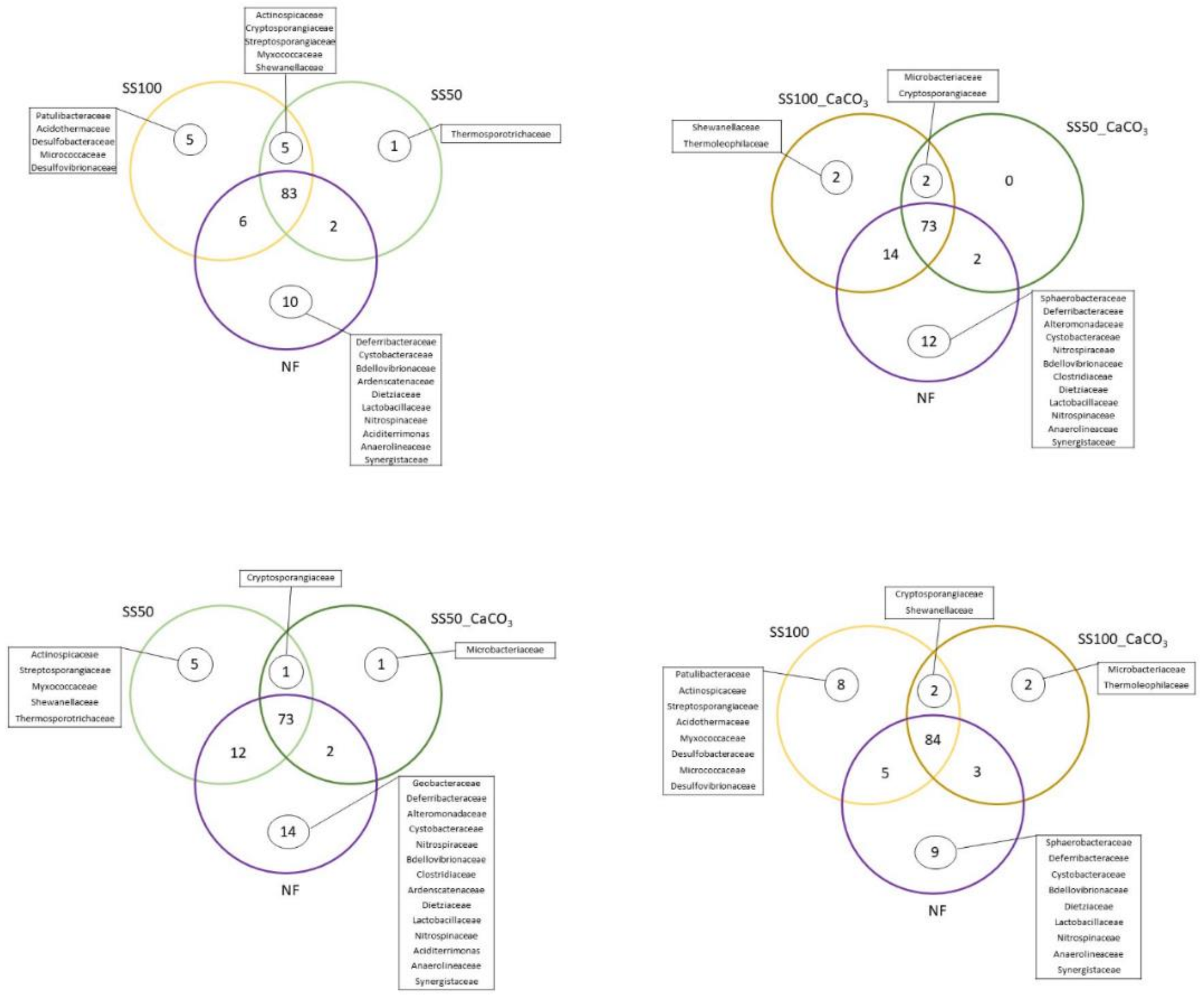

Figure 3: Venn diagram showing the overlap of the bacterial communities from the different soil treatments including only SS (a) or SS + $CaCO_3$ (b) and overlap of family communities between both treatments including the low dose of SS (c) or the high dose of SS (d). Only families present in at least 3 of the 6 soil replicate samples were considered for this analysis.

Source: Vanessa Álvarez-López (Universidade da Coruña, UDC, Spain).

5. Development of a new tool for the soil C market: an example of public-private partnership

The demand for efficient, accurate, cost-effective methods of measuring soil C in agriculture is growing. In this project, we demonstrated the ability of the laser-induced breakdown spectroscopy (LIBS) method as a more economical and faster technique, than for example CHN analyser, and with adequate accuracy for soil C quantification of 1,019 soil samples from 11 Brazilian farms under croplands use, mainly with maize, soybean and cotton cultivation, under conservative tillage (no-tillage). In this relevant on-farm research project, called PRO Carbon (developed in a public-private partnership, between Bayer Company and Embrapa), soil samples collected to 1 m depth, from three different Brazilian biomes (Savannah, Atlantic Forest and Pampa), constituted important physical-chemical matrix effects challenges to LIBS analysis. Using the artificial neural network calibration strategy was obtained the best LIBS results with the lowest root mean square error of prediction of 0.48 wt% C, an excellent result considering the comparison to 0.30 wt% C of the intrinsic instrumental error to CHN analysers. Using these data of soil C content, determined by LIBS, with soil density measurements, based on the volumetric ring method, the soil C stocks were determined for these 11 farms. Main observations were obtained by making a comparison of agricultural soils under no-tillage practice, with at least two annual crop seasons (generally soybean and maize or soybean and cotton) with native vegetation areas. Mainly in the farms from Savannah biome (Brazilian Cerrado) soil carbon stocks in agricultural soils were bigger than native vegetation indicating soil carbon sequestration situations. On the other hand, the demonstration of the LIBS technique as a reliable tool for soil C quantification, with a lower cost of analysis, generates stimulus for farmers' participation in the soil C global market.

For detailed information please see Frontiers in Soil Science (23rd January 2024).

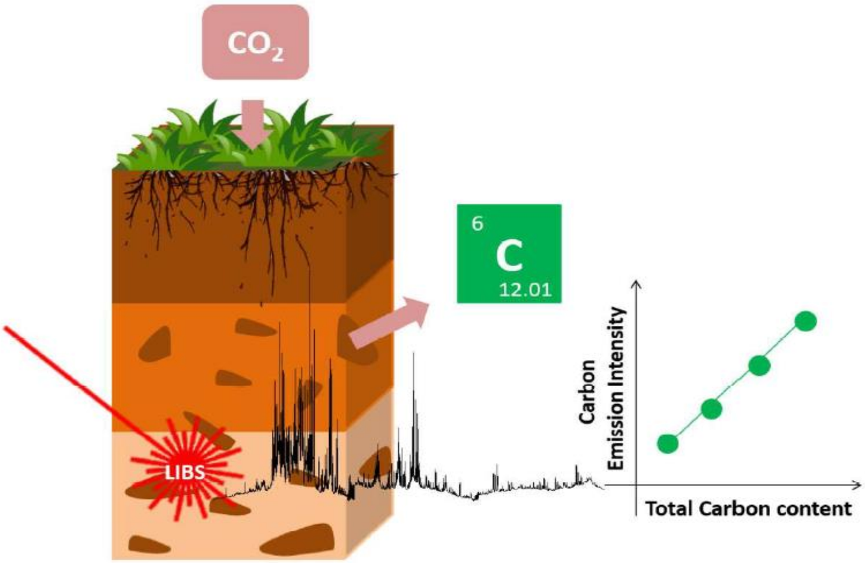

Figure 4: Laser-induced breakdown spectroscopy (LIBS) method for soil C quantification.

Source: Ladislau Martin Neto (Senior Scientific Researcher Embrapa, Brazil, Co-Chair CRG).

6. Evaluation of ROTH-C model for predicting soil organic carbon stock

Soil organic carbon (SOC) plays a significant role in water retention, nutrient cycling, soil health, sustainable agricultural production and food security. + Bethel Geremew from Haramaya University in Ethiopia recently completed her CLIFF-GRADS training in carbon modeling under the supervision of the U.S. Co-Lead of the GRA-CRG at the USDA-Columbia Plateau Conservation Research Center in Pendleton, Oregon, and published two manuscripts with collaborators from the University of Nebraska and Haramaya University. She used the Rothamsted Carbon (RothC) model, long-term climate, soil, and land management inputs to assess the current and future SOC stocks at the Anjeni watershed, Ethiopia. The results indicated that grassland had the highest current and projected SOC compared to cultivated land and plantation forest. Furthermore, grassland of a gentle slope gradient had higher SOC compared to the middle and high elevation section of the watershed. Overall, the model projected an increase in SOC that could improve water retention, and reduce greenhouse gas emissions, which in turn could enhance agricultural productivity, food security and sustainable development.

For detailed information, please see Environmental ChallengesVolume, 15, Article 100909.

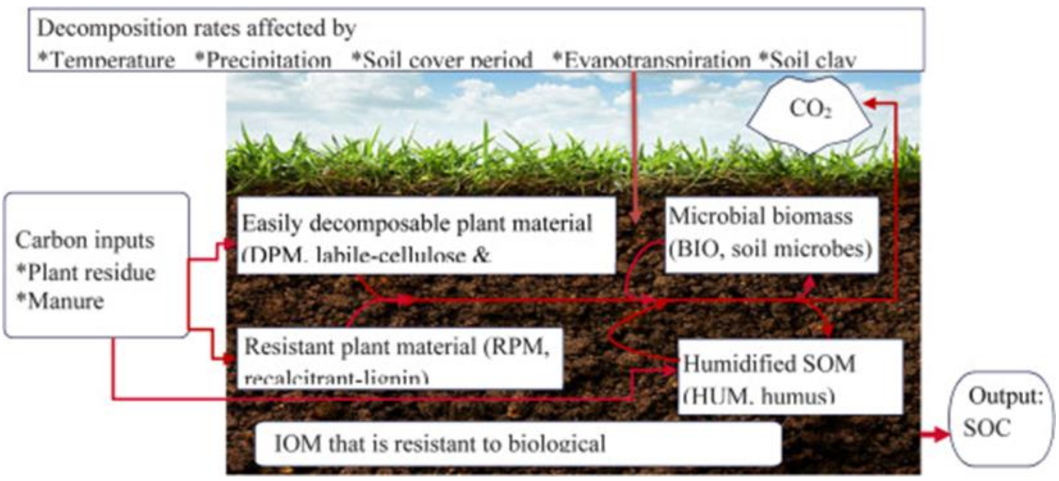

Figure 5: RothC model structure.

Source: Hero Gollany (Research Soil Scientist at the USDA-ARS, USA, GRA-CRG Co-Chair).

7. Synchronizing nitrogen fertilization and planting date to improve resource use efficiency

Synchronizing nitrogen (N) fertilization with planting dates could enhance water and nutrient use efficiency and profitability of upland rice production. Tajamul Hussain from Prince of Songkla University in Thailand joined CLIFF-GRADS training in carbon modelling under the supervision of the U.S Co-Lead of the GRA-CRG at the USDA-Columbia Plateau Conservation Research Center in Pendleton, OR, and published a manuscript with collaborators from the University of Minnesota and Arid Agriculture University, Pakistan. The objectives of this study were to assess the upland rice responses to four N fertilizer rates and three planting dates. Four N fertilization rates were: 0, 30, 60 and 90 kg ha^{-1}, and applied at the tillering and panicle emergence stages. The planting dates selected were between September and December of each growing season. The fertilization rates and planting times influenced the N uptake, N use efficiencies, crop water productivity, yield, yield attributes, and profitability of upland rice production. There were linear relationships between N fertilizer rate, grain yield, and aboveground biomass. Grain N, total N, straw N, and N uptake were increased by 159%, 159%, and 160% during the first season and by 90%, 114%, and 153% during the second season, respectively. Highly significant and positive associations were observed among agronomic attributes, N uptake, N efficiencies and the crop water productivity of upland rice in correlation assessments. Maximum profitability from grain yield was 90 kg N ha^{-1} under all planting times. Results suggest that N fertilization rates of 90 kg ha^{-1} and rice planting at the end of September and the start of October would enhance productivity, resource use efficiency and maximize profitability.

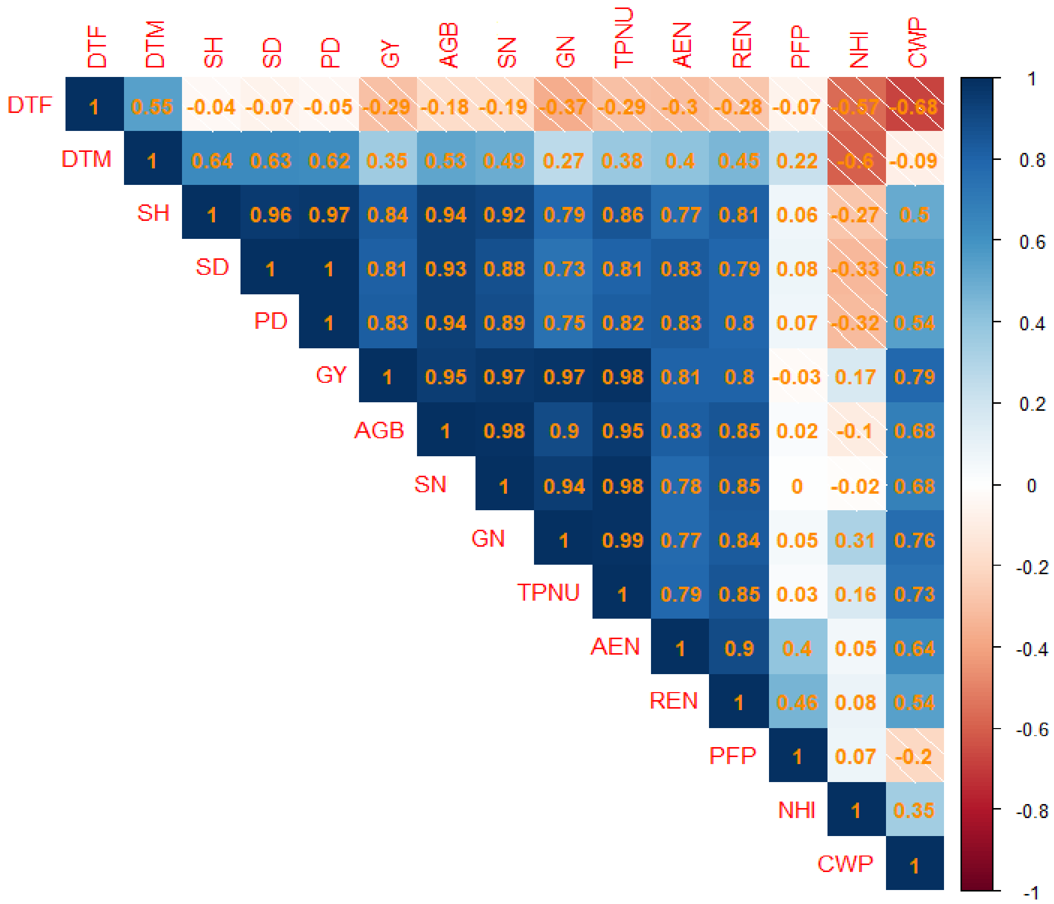

Figure 6: Pearson's correlation analysis of studied traits for upland rice.

Shaded squares indicate positive or negative associations among attributes. Computed Pearson's correlation coefficients are reported in the squares. The intensity of color shades is proportional to the coefficients. Days to flowering (DTF); Days to maturity (DTM); Stem height (SH); Stem density (SD); Panicle density (PD); Grain yield (GY); Aboveground biomass (AGV); Straw nitrogen content (SN); Grain N content (GN); Total plant N uptake (TPNU); Agronomic efficiency of applied N (AEN); Recovery efficiency of applied N (REN); Partial factor productivity (PFP); N harvest index (NHI); and Crop water productivity (CWP).

For detailed information, please see Frontiers in Plant Science, 13, Article 895811.

Source: Hero Gollany (Research Soil Scientist at the USDA-ARS, USA, GRA-CRG Co-Chair).

8. Upcoming events

X International Congress of Agroecology

The X International Congress of Agroecology will be held in Viseu, Portugal, during **2nd – 6th September 2024**. The objectives of this congress are: i) Contribute to the production, consolidation and sharing of agroecological knowledge and experiences, in promoting the transition to sustainable food systems through debate and consensus on the common elements between the world's agroecologies, ii) Continue the process of configuring agroecological strategies as integral responses (technological, socioeconomic and environmental) for a resilient food system, with the capacity to respond to the challenges of climate change, poverty and socioeconomic polarization, iii) Give visibility to agroecologies from the Global South to the North. More information here.

2024 ASA, CSSA, SSSA International Annual Meeting

And CRG Annual Meeting

The 2024 ASA, CSSA, SSSA International Annual Meeting will be held in San Antonio, Texas, USA, during **10th – 13th November 2024**. The American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America jointly host the premier gathering of ideas, solutions, and innovation from across the field of environmental sciences. This Annual Meeting is equal parts science, networking, collaboration, and camaraderie. Emerging learners and leaders from industry, government agencies, and academic institutions are welcome to explore advances in agronomic, crop and soil sciences. More information here.

The GRA's CRG Annual Meeting will occur on November 14th alongside the "2024 ASA, CSSA, SSSA International Annual Meeting".

23rd European Grassland Federation (EGF) Symposium

The 23rd EGF symposium will be held in Reading, UK, during **15th – 17th September 2025**. The conference website will be available soon. More information here.

31st European Grassland Federation (EGF) meeting

The 31st EGF meeting will be held in Evora, Portugal, during **12th – 16th April 2026.** The meeting will focus on grassland challenges for a changing world. The main topics of the meeting will be i) Climate change and grasslands, soil and water management, ii) Agroforestry, iii) Breeding for new challenges, iv) Pastoralism and society, v) Grasslands and rural land policy tools. More information here.

XXVI International Grassland Congress

The XXVI International Grassland Congress will be held in Leipzig, Germany during **13th – 18th June 2027**. The theme of the conference is “100 years of grassland research – ways to the future”. More information here.

This is your newsletter! If there’s anything you think should be included, please send suggestions to mrosa.mosquera.losada@usc.es for the next issue

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