PRELIMINARY RESULT OF THE CARBON STOCK ESTIMATE IN THE SÃO PAULO AND WEST-SOUTHWEST MINAS GERAIS CITRUS BELT

Fundecitrus
SCIENCE AND SUSTAINABILITY
IN CITRICULTURE

Embrapa
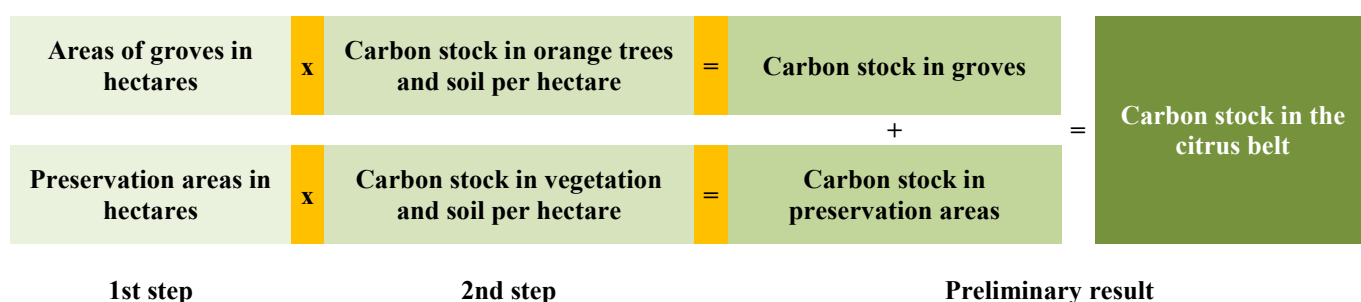*Territorial*

PES

PRELIMINARY RESULT

1 – PRELIMINARY RESULT OF THE CARBON STOCK ESTIMATE IN THE SÃO PAULO AND WEST-SOUTHWEST MINAS GERAIS CITRUS BELT

The Empresa Brasileira de Pesquisa Agropecuária (Embrapa) and the Fundo de Defesa da Citricultura (Fundecitrus) started a joint scientific research project in 2022 to quantify carbon stocks and identify the wild fauna present in the citrus belt in the state of São Paulo and Minas Gerais (Southwest and West). The project received funding from the British company Innocent Drinks, after being selected in response to a public notice of the company's innovation fund, among proposals from several countries.

The work in the citrus belt aims to provide data on carbon storage in the segment, in an unprecedented way, and involves both orange groves and areas intended for the preservation of native vegetation on rural properties, in a territory of almost 600,000 hectares. Different methodologies are being used for the production and preservation areas, which are briefly presented below.

In estimating the carbon stock of orange farms in the citrus belt, areas of orange groves older than three years and areas dedicated to environmental preservation (permanent preservation areas, legal reserve areas and areas of exceeding native vegetation) were considered. In orange production areas, only orange trees of the main varieties were considered, which include Alvorada, Hamlin, Natal, Pera Rio, Pineapple, Rubi, Seleta, Valencia, Valencia Americana, Valencia Folha Murcha and Westin. In those groves, only trees of the same age as the plot were considered. Thus, replants younger than the plot age were not considered in the calculation. The compartments measured were biomass and soil.

In summary, the estimate was carried out in two steps, as follows:

Areas of groves in hectares	x	Carbon stock in orange trees and soil per hectare	=	Carbon stock in groves		Carbon stock in the citrus belt
				+	=	
Preservation areas in hectares	x	Carbon stock in vegetation and soil per hectare	=	Carbon stock in preservation areas		

| **1st step** | **2nd step** | **Preliminary result** |

The first step was to determine the areas of groves and preservation areas in hectares, as shown in Figure 1.

Figure 1 – Location of areas dedicated to environmental preservation on orange farms and areas with orange groves
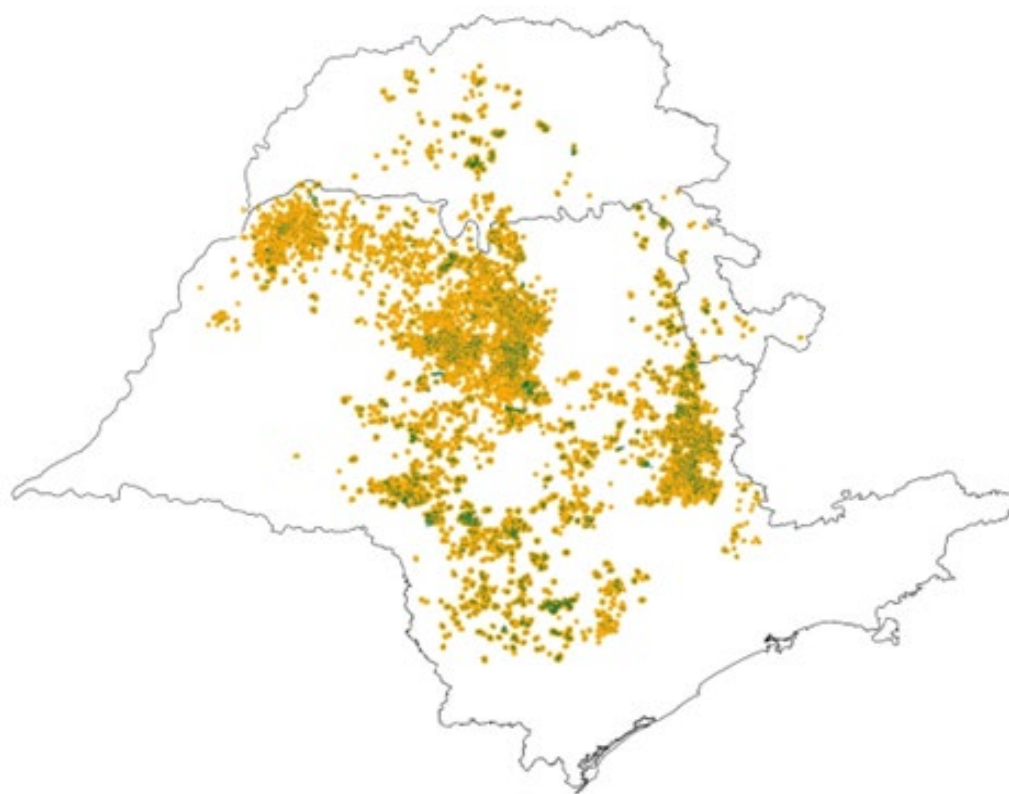
■ **Orange areas**
■ **Areas dedicated to the conservation of native vegetation**

Information about areas of groves were extracted from the "Tree Inventory of the São Paulo and West-Southwest Minas Gerais Citrus Belt: Snapshot of Groves in March 2023".

Preservation areas in hectares were determined through the use of data from the Sistema Nacional do Cadastro Ambiental Rural (SICAR, 2023) and the vegetation cover of these areas was determined through the use of data from the Instituto Brasileiro de Geografia e Estatística (IBGE, 2023) and data from the MapBiomas land use and land cover map for the year 2021 (PROJETO MAPBIOMAS, 2023).

The second step was to determine carbon stocks in tons per hectare of the different age classes of groves and of the different types of vegetation cover in the preservation areas.

Destructive direct sampling was used to estimate the carbon stock of orange trees (trunk, branches, leaves and roots). Eighty orange trees (40 Pera and 40 Valencia) that best represented citrus belt plants were assessed, considering 20 orange trees aged 3 to 5, 6 to 10, 11 to 15 and over 15 years. Plants were measured in the field (diameter of the trunk and primary and secondary branches, and plant height), and then they were separated into trunk, branches, leaves and roots and weighed fresh. Then, fresh samples of each part were weighed in the field. In the laboratory, these fresh samples were dried in an oven (65ºC until constant weight) to determine the % (percentage) of the dry biomass of each part of the plant. To create an allometric equation, a regression analysis was performed (Backward elimination – Stepwise), with the dry weight of the total biomass of each of the 80 assessed plants as the dependent variable, and the basal area of the trunk, primary and secondary branches, and plant height as the independent variables. In the analysis that presented an R square of 0.9187, an allometric equation was created with the following predictive variables: plant height, basal area of the trunk and basal area of secondary branches.

The allometric equation was developed jointly with José Carlos Barbosa, Voluntary Full Professor at the Department of Math and Science at FCAV/Unesp. The allometric equation was applied to the 3,465 plants sampled for the Crop Forecast Survey (PES) in the citrus belt, resulting in an estimate of the dry biomass stock of these plants, which was extrapolated to the entire citrus belt. The elemental carbon of the plant was determined through the chemical analysis of 64 samples, with the use of the LECO apparatus, finding a weighted average of 47% of carbon per kg of dry biomass. That is, for each kg of dry biomass, 0.47 kg is carbon. Thus, to estimate the carbon stock, the biomass stock was multiplied by the average carbon content of the stratum composed of "variety and age" for the Pera Rio and Valencia varieties, and the average content by age for the other varieties, as shown in Table 1.

Tabela 1 – Carbon content (%) by variety and age used in estimating the carbon stock of biomass in orange groves

Variety	Age (years)	Carbon content (%)
Pera Rio	3 to 5 years	46.97
Pera Rio	6 to 10 years	46.69
Pera Rio	11 to 15 years	47.22
Pera Rio	Over 15 years	47.14
Valencia	3 to 5 years	46.38
Valencia	6 to 10 years	46.87
Valencia	11 to 15 years	47.41
Valencia	Over 15 years	46.81
Other varieties	3 to 5 years	46.66
Other varieties	6 to 10 years	46.80
Other varieties	11 to 15 years	47.32
Other varieties	Over 15 years	46.93

Data from the Inventário Nacional de Gases de Efeito Estufa (BRASIL, 2020) were used to estimate the carbon stock in the biomass of preservation areas, considering the different phytophysiognomies of the vegetation present in the Cerrado and Atlantic Forest biomes and the different types of land use/cover.
In estimating the stock of carbon in the soil in the areas of groves and conservation areas, the soil organic carbon map in the 0-30 cm layer was used (VASQUES et al., 2021).

Finally, the carbon stocks in the soil and in the biomass of groves and preservation areas were added, resulting in a stock of approximately 36 million tons of carbon.

To obtain the carbon dioxide equivalent stock (CO_2 eq.), the preliminary result of the carbon stock estimate was multiplied by 3.66, which is the carbon equivalent weight of the CO2 molecule, resulting in approximately 133 million tons of CO_2 eq. in the citrus belt.

This information confirms the importance of citrus growers' participation in maintaining carbon stocks in orange farms and highlights their potential to contribute to the mitigation of climate change.

Details of methodologies and final results of carbon stock estimates in the citrus belt are in the process of being published in scientific journals and will be released in due course.

References

BRASIL. Quarto inventário nacional de emissões e remoções antrópicas de gases de efeito estufa. Relatório de referência: Setor uso da terra, mudança do uso da terra e florestas. Brasília: Ministério da Ciência, Tecnologia e Inovação. 2020. Disponível em: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/relatorios-de-referencia-setorial>. Acesso em: 06 de março de 2023.

IBGE. Instituto Brasileiro de Geografia e Estatística. Vegetação 1:250.000. Disponível em: <https://www.ibge.gov.br/geociencias/informacoes-ambientais/vegetacao/22453-cartas-1-250-000.html?=&t=downloads>. Acesso em: 06 de março de 2023.

PROJETO MAPBIOMAS. Coleção 7 da Série Anual de Mapas de Cobertura e Uso de Solo do Brasil. Disponível em: <https://code.earthengine.google.com/?accept_repo=users%2Fmapbiomas%2Fuser-toolkit&scriptPath=users%2Fmapbiomas%2Fuser-toolkit%3Amapbiomas-user-toolkit-lulc.js>. Acesso em: 06 de março de 2023.

SICAR. Sistema Nacional de Cadastro Ambiental Rural. Cadastro Ambiental Rural. Disponível em: <https://www.car.gov.br/publico/municipios/downloads>. Acesso em: 06 de março de 2023.

VASQUES, G. de M.; DART, R. de O.; BACA, J. F. M.; CEDDIA, M. B.; MENDONÇA SANTOS, M. de L. Mapa de estoque de carbono orgânico do solo do Brasil (90 m - Versão 2021). Rio de Janeiro: Embrapa Solos, 2021. Disponível em: <http://geoinfo.cnps.embrapa.br/maps/3175>. Acesso em: 06 de março de 2023.