



Food and Agriculture  
Organization of the  
United Nations

GLOBAL  
SYMPOSIUM on  
**SOILS** and **WATER**

02-05 October, 2023

Soil and water:  
a source of life



Soil physical quality indicators for water management in  
areas cultivated with avocado (*Persea americana* cv.  
*Hass*) (Cauca – Colombia).

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**AGROSAVIA**30  
40 años

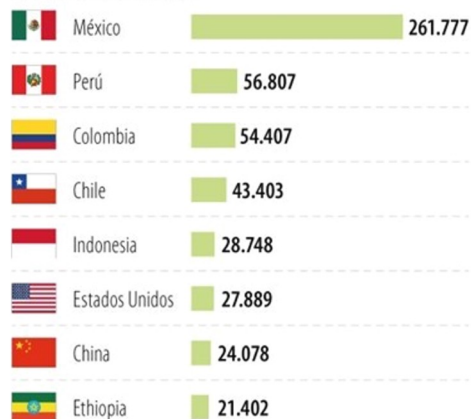
Corporación colombiana de investigación agropecuaria



## Hass avocado market projection

### AGUACATE HASS COLOMBIANO EN EL MERCADO INTERNACIONAL

#### ÁREA COSECHADA



#### PRODUCCIÓN (toneladas)



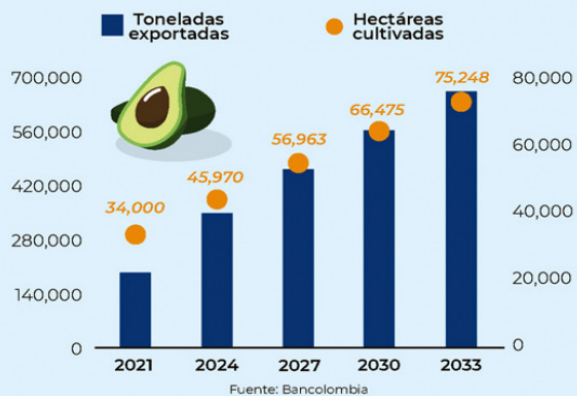
[https://img.lalr.co/cms/2021/03/19193451/Eco\\_aguacateHass\\_WEB-Agro.jpg?r=16\\_9](https://img.lalr.co/cms/2021/03/19193451/Eco_aguacateHass_WEB-Agro.jpg?r=16_9)

*“Regarding the competitive export power of Colombia, the limitations are:*

- *Fruit harvest and postharvest quality guidelines*
- *Harvesting materials supported by international standards.*
- *Diversity of conditions of the producing farms that cause a variety in production by territory and by locality of the same department.”* (Rodríguez, 2018)



### Proyección del área cultivada y exportación de aguacate Hass de Colombia



<https://www.agromeat.com/312720/colombia-en-15-anos-el-aguacate-hass-sera-el-producto-estrella-de-las-exportaciones>. Abril 2021

<https://latinometrics.substack.com/p/corruption-flowers-and-colombian>

aguacate hass colombiano meg...  
s exportaciones en 2020 por encima de 25% en valor y  
lumen



<https://www.minagricultura.gov.co/noticias/Paginas/Aguacate-hass-colombiano-ileg%C3%B3-a-China>. Julio 2020

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## Areas suitable for Hass avocado (1:10000)

Suitable áreas (Ha)

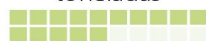
3,3 millones de hectáreas

Cultivated áreas (Ha)

25.000 hectáreas Equivalente del potencial 1%

Annual production (t)

149.000 toneladas



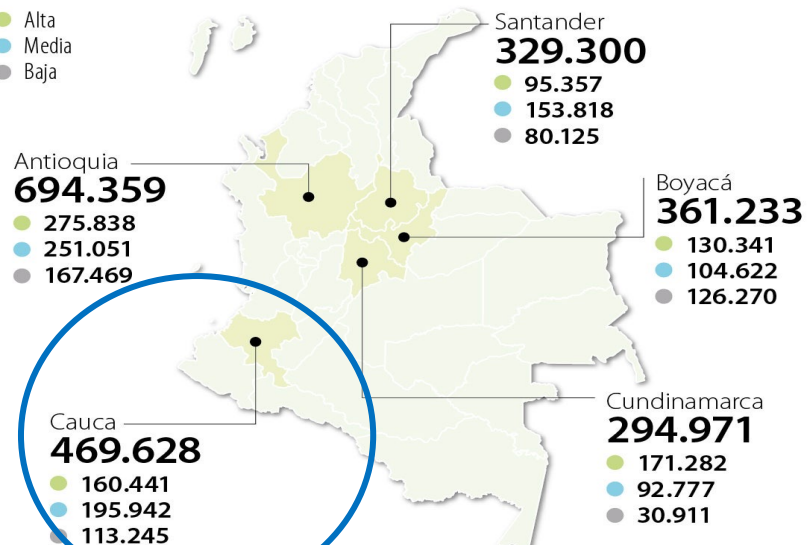
### Hass Avocado Yield

Colombia 11 t ha<sup>-1</sup> Vs Cauca 5,9 t ha<sup>-1</sup>

Low availability of specific technological tools for crop management

MAYOR APTITUD PARA EL CULTIVO DE HASS POR DEPARTAMENTO Cifras en hectáreas

- Alta
- Media
- Baja



(UPRA, 2018)



1. Characterization and analysis of current producing areas.
2. Crop requirements, its physiology and land evaluation.



<https://www.agronegocios.co/agricultura/van-mas-de-25000-hectareas-cultivadas-de-hass-y-hay-un-potencial-de-33-millones-3043515>. Agosto 2020.



# Objective

*Analyze physical quality indicators of the soil associated with the accumulation and movement of water in hass avocado (*Persea Americana* cv. Hass) producing areas in the Department of Cauca.*

Project “Development and validation of technologies to increase the productivity of Hass avocado cultivation in the Department of Cauca”

- **Functions in the soil** such as the provision of nutrients and water for the development of a crop: it depends on the quality and health of the soil.
- **Quality:** specific capacity of a soil to function in a natural or anthropic ecosystem in accordance with its functions: (1) promote the productivity of the system without losing its physical, chemical and biological properties (sustainable biological productivity); (2) attenuate environmental contaminants and pathogens (environmental quality); and (3) promote the health of plants, animals and humans (Doran & Parkin, 1994).

# Methodology



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# Methodology

## ➤ Sampling sites



Avocado crops (*Persea americana* cv. Hass): (34)



## ➤ Soil sampling



Soil characterization: Effective depth, color, structure, chemical analysis (0 – 20 cm).



Undisturbed samples - cylinders: boxes (3) 50 x 50 cm. Depths: 0 – 15 cm; 15 – 30 cm.



Laboratory analysis: density, texture

## ➤ Variables

- Soil moisture content: field capacity, permanent wilting point, Saturated water content, Available water content.
- Bulk density
- Particle density
- Hydraulic Conductivity
- Texture
- Total Porosity
- Pore distribution

## ➤ Data processing and analysis

Descriptive statistics – correlation of variables. Multivariate analysis for identification of physical indicators

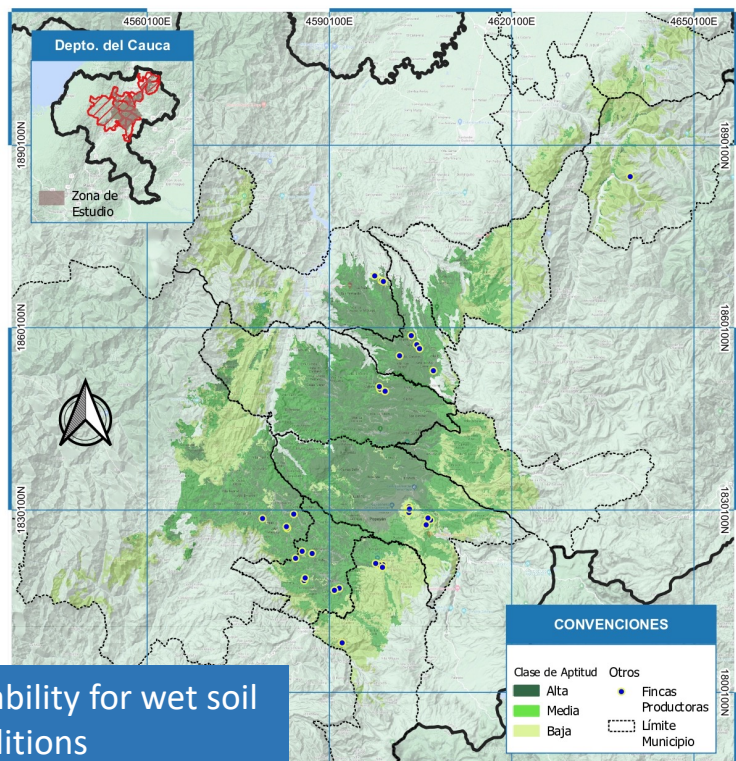
# Results



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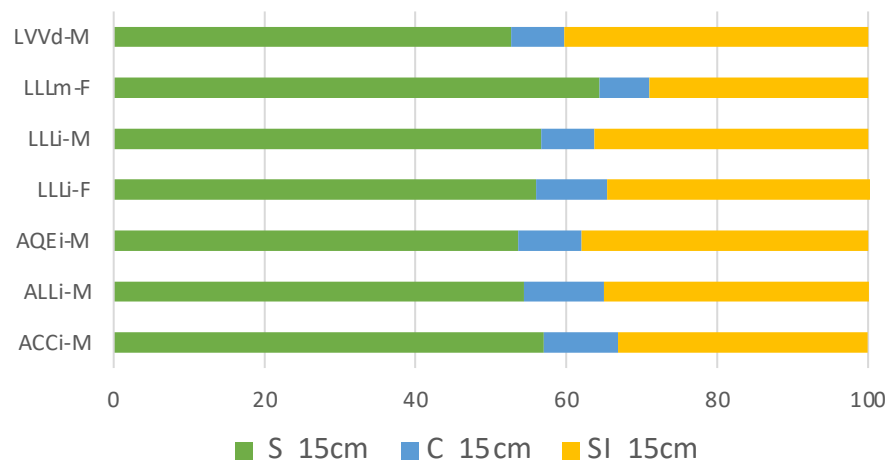


# Soil physical conditions \_ Crops



Suitability for wet soil conditions

Particle-size distribution (%) 0 - 15 cm

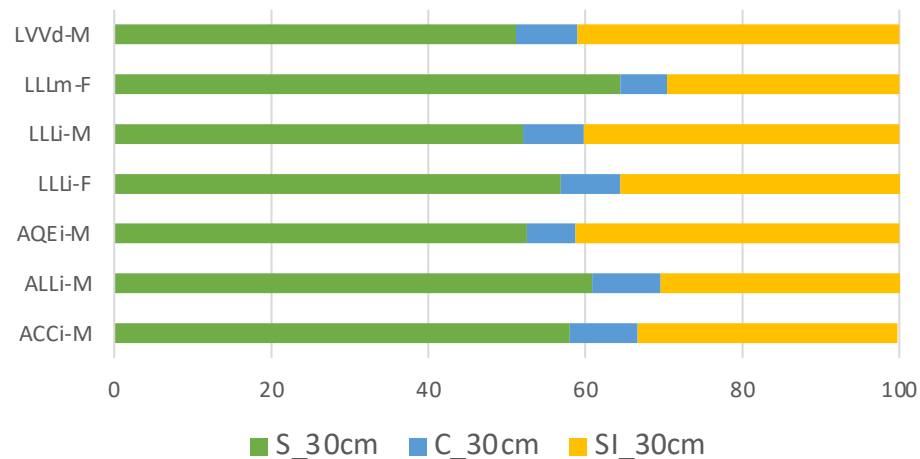


Sand (S) (57%) > Silt (SI) (34.1%) > Clay (C) (8.8%)

Loam (L) and Loamy sand (LS)



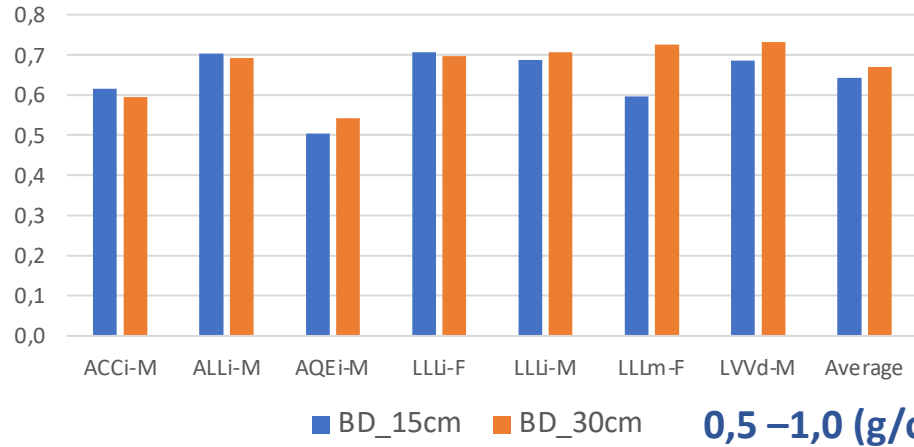
Particle-size distribution (%) 15 - 30 cm



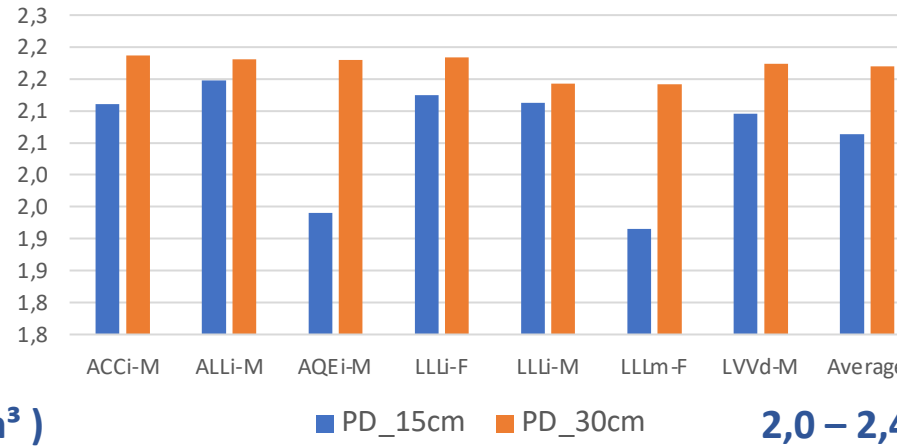
Soil Cartographic Unit (SCU)	Profile	Taxonomic unit	Sites (#)	m.a.s.l.
ACCi-M	FN-07	Typic Hapludand	8	
AQEi-M	FN-12	Typic Melanudand	1	1600 - 1800
ALLi-M	FN-02	Typic Hapludand	13	
LLLi-F	MC-209	Typic Hapludand	9	
LLLi-M	FN-14	Typic Hapludand	1	1800 - 1980
LLLm-F	SP-02	Typic Hapludand	1	
LVVd-M	SP-03	Typic Humudept	1	

# Soil physical conditions \_ Crops

Bulk density (BD) (g/cm<sup>3</sup>)

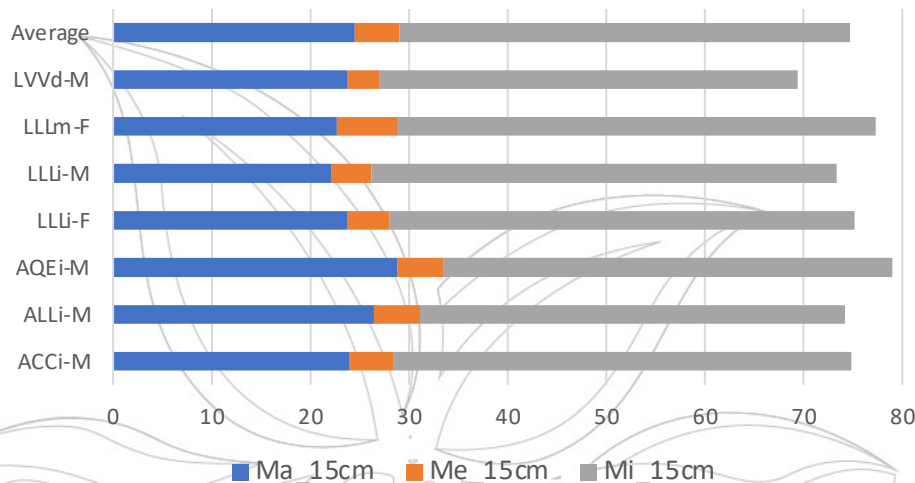


Particle density (PD) (g/cm<sup>3</sup>)

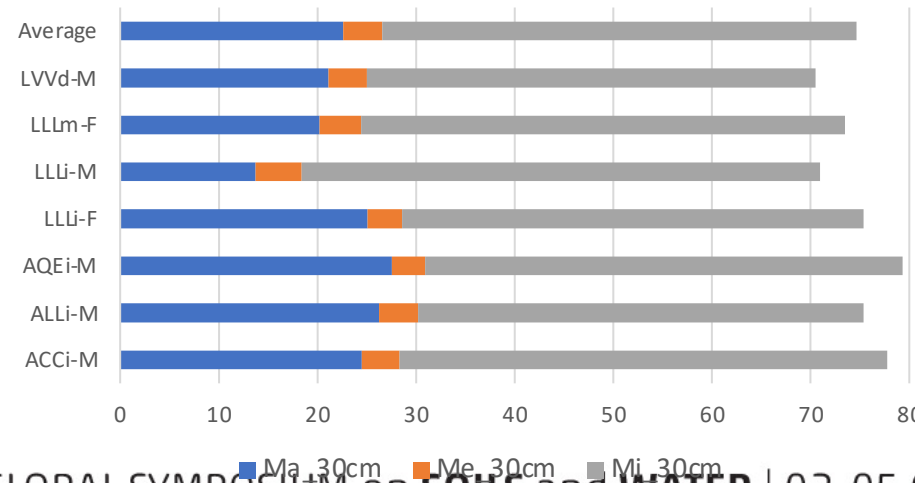


**Total Porosity**  
69.4 – 81.2%

Pore size distribution (PSD) (%) 0 - 15 cm



Pore size distribution (PSD) (%) 15 - 30 cm

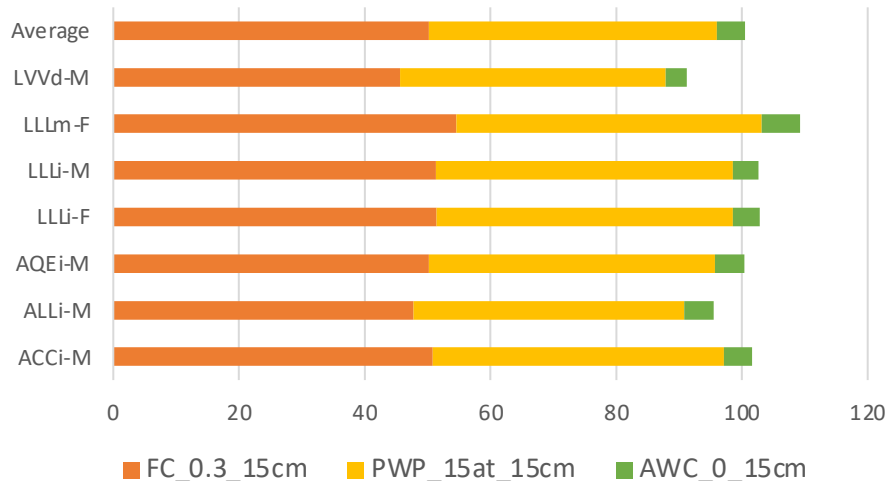


**Micropores (Mi) (46.5%) >**  
**Macropores (Ma) (25.1%) >**  
**Mesopores (Me) (4.4%)**

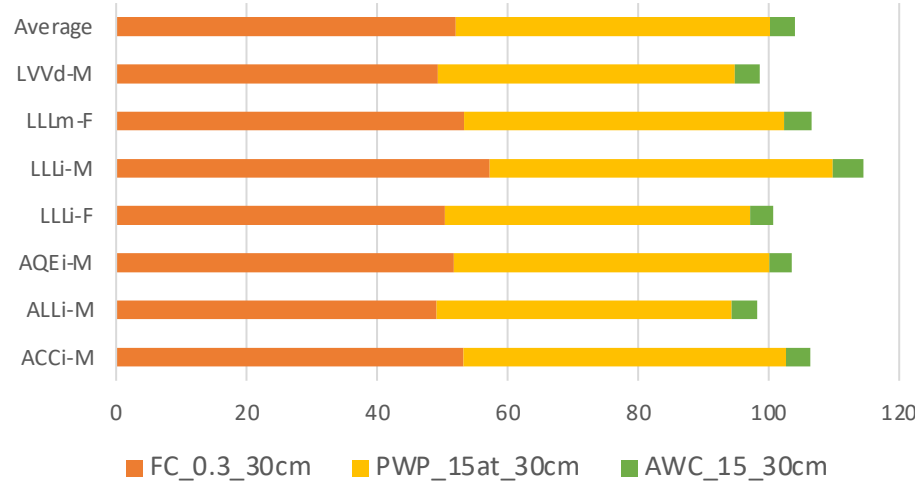
**Results**

# Soil physical conditions \_ Crops

Soil moisture content (%). 0 - 15 cm



Soil moisture content (%). 15 - 30 cm

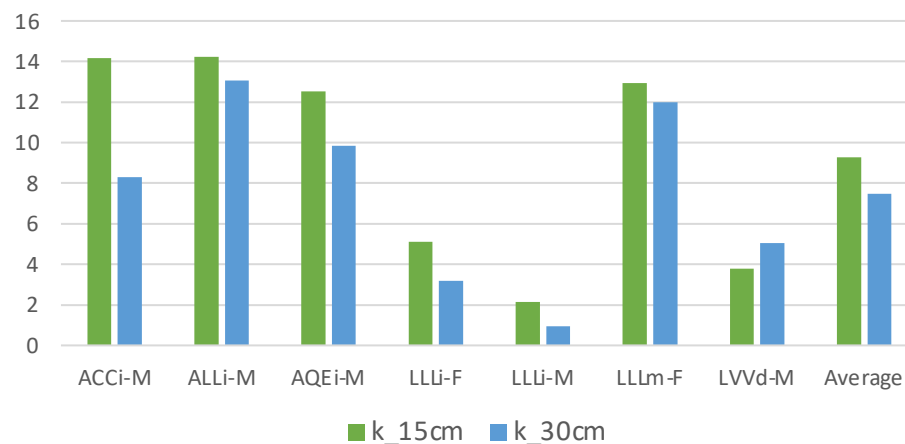


**Field capacity (FC) (0.3 bar) : 42.3 – 57.2%,**

**Permanent wilting percentage (PWP) (15 bar): 37 – 53.9%.**

**Available water content (AWC) < 5%**

Hidraulic conductivity (k) (cm/h)



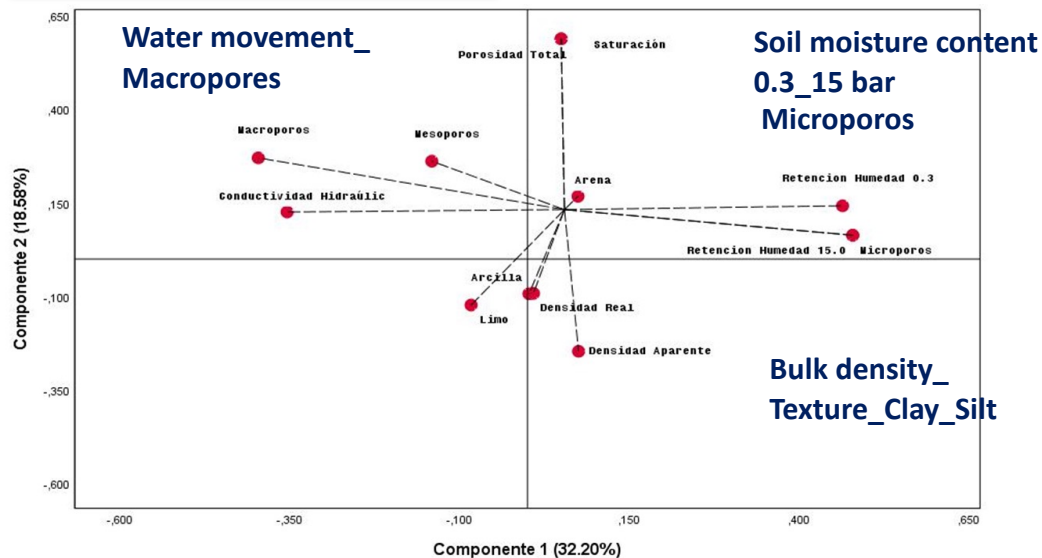
**Moderately high to high**

**Results**

# Soil quality physical indicators

## Physical 0 – 15 cm

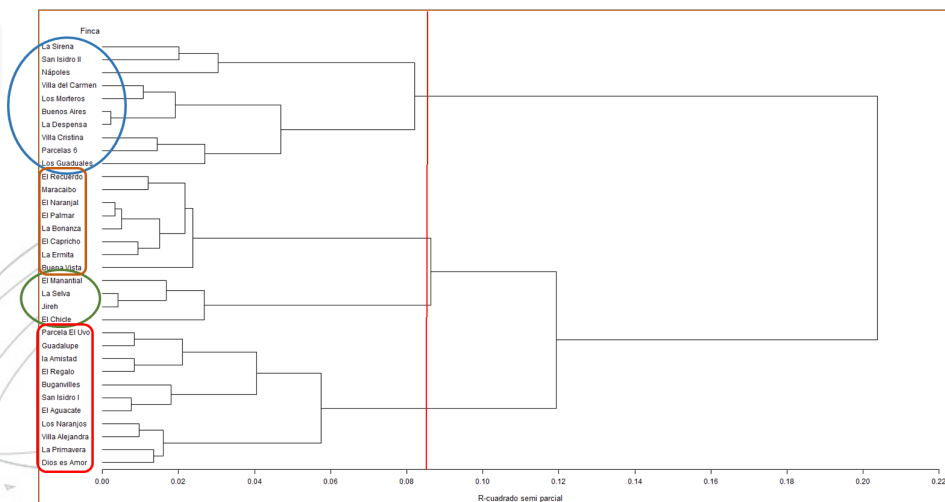
## Contributions



Variable	Bulk density	Saturated water content	Field Capacity 0.3 bar	Permanent wilting point 15 bar	Hidraulic Conductivity	Macropores
Permanent wilting point 15 bar	0,047 ns	0,204 ns	0,962 ***	1		
Hidraulic Conductivity	-0,360 **	0,004 ns	-0,566 ***	-0,619 ***	1	
Macropores	-0,086 ns	0,445 **	-0,751 ***	-0,752 ***	0,528 **	1
Microporos	0,047 ns	0,204 ns	0,962 ***	1,000 ***	-0,619 ***	-0,752 ***
Total Porosity	-0,144 ns	1,000 ***	0,257 ns	0,204 ns	0,004 ns	0,445 **

\*\*\* ( $p < 0.001$ ); \*\* ( $p < 0.01$ ); \* ( $p < 0.05$ ); ns = not significantly

## Farm Groups



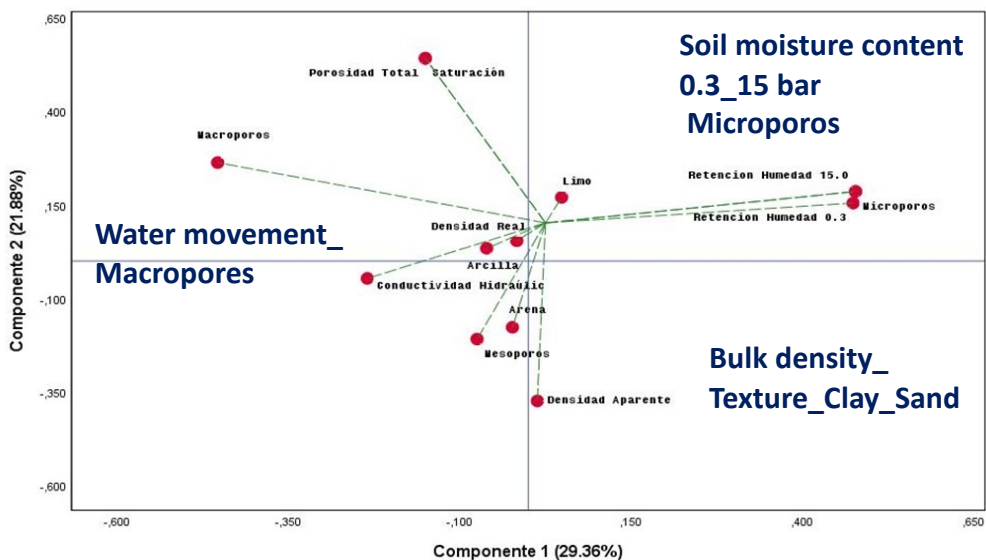
## Results

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# Soil quality physical indicators

## Físicas 15 – 30 cm

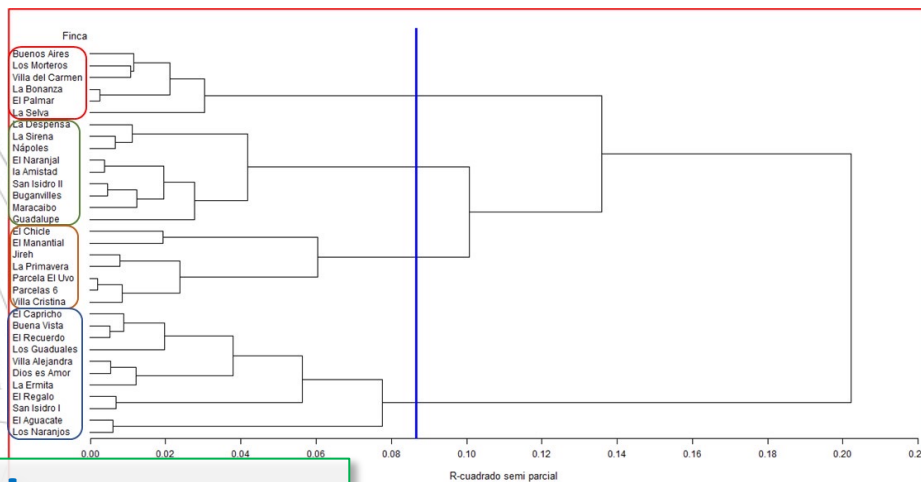
## Contributions



Variable	Bulk density	Saturated wáter content	Field Capacity 0.3 bar	Pemanent wilting point 15 bar	Hidraulic Conductivity	Macropores
Saturated wáter content	-0,516**	1				
Pemanent wilting point 15 bar	-0,189 ns	0,048 ns	0,987***	1		
Hidraulic Conductivity	-0,377*	0,087 ns	-0,293 ns	-0,349*	1	
Macropores	-0,227 ns	0,678***	-0,719***	-0,692***	0,276 ns	1
Mesopores	0,079 ns	-0,149 ns	-0,031 ns	-0,194 ns	0,372*	-0,081 ns
Micropores	-0,189 ns	0,048 ns	0,987***	1,000***	-0,349*	-0,692***
Total Porosity	-0,516**	1,000***	0,024 ns	0,048 ns	0,087 ns	0,678***

\*\*\* ( $p < 0.001$ ); \*\* ( $p < 0.01$ ); \* ( $p < 0.05$ ); ns = not significantly

## Farm Groups



## Results

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# Conclusions

- The analysis allows us to establish that the evaluated areas have terrain characteristics that favor conditions for the establishment of Hass avocado crops, such as texture, effective depth, drainage and oxygen availability, conditioning factors for crop productivity.
- According to the physical characteristics analyzed in the area, it was possible to identify groups of soils with similar properties that allow defining differential zones for physical suitability and that influence the accumulation and movement of water in the soil and therefore crop production.



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# Appropriation of results



Global Soil Doctors Programme

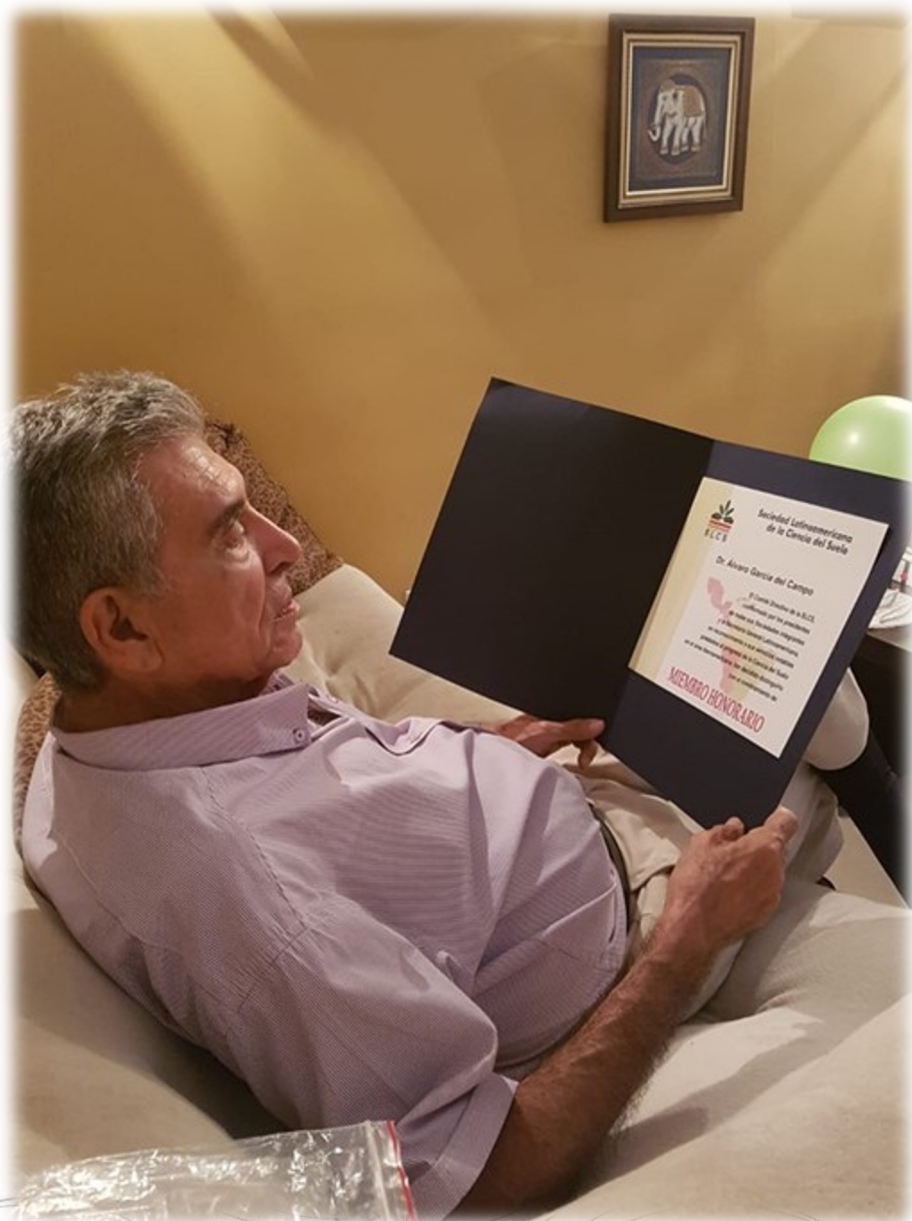
<https://www.youtube.com/@GlobalSoilDoctorsProgramme>

<https://youtu.be/zHUcsRbxORk>

Technology transfer AGROSAVIA

<https://youtu.be/WMvhaeqkROA>





***In memory of Doctor Alvaro Garcia Ocampo.  
I. A. Ph. D.***

*Prominent Colombian researcher in the area of chemistry, soil fertility and crop nutrition.*

*Master of several generations in soil sciences.*

*Honorary Member of the Latin American Society of Soil Science.*

*Colombian Society of Soil Science Ex - president.*

*Soil Fertility and Plant Nutrition commission Ex -Chair.  
International Union of Soil Sciences (IUSS).*

*Q.E.P.D*



# Thanks !!!!



MINISTERIO DE AGRICULTURA  
Y DESARROLLO RURAL

Desarrollo y validación de tecnologías para  
incrementar la productividad del cultivo de  
aguacate Hass en el departamento del Cauca



Conservemos los suelos sanos y fértiles, son el soporte de nuestros campos.

