Soil Health in Colombian Coffee Farms and Associated Farmers' Perceptions

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Introduction

Coffee (Coffea spp.) is a high value globally traded commodity that is second in total commercial value only to petroleum in the developing world. Drastic changes in global-coffee markets have negatively affected smallholder coffee growers' profitability.

Aribica Coffee Price 1970 to 2016
Source: International Coffee Organization
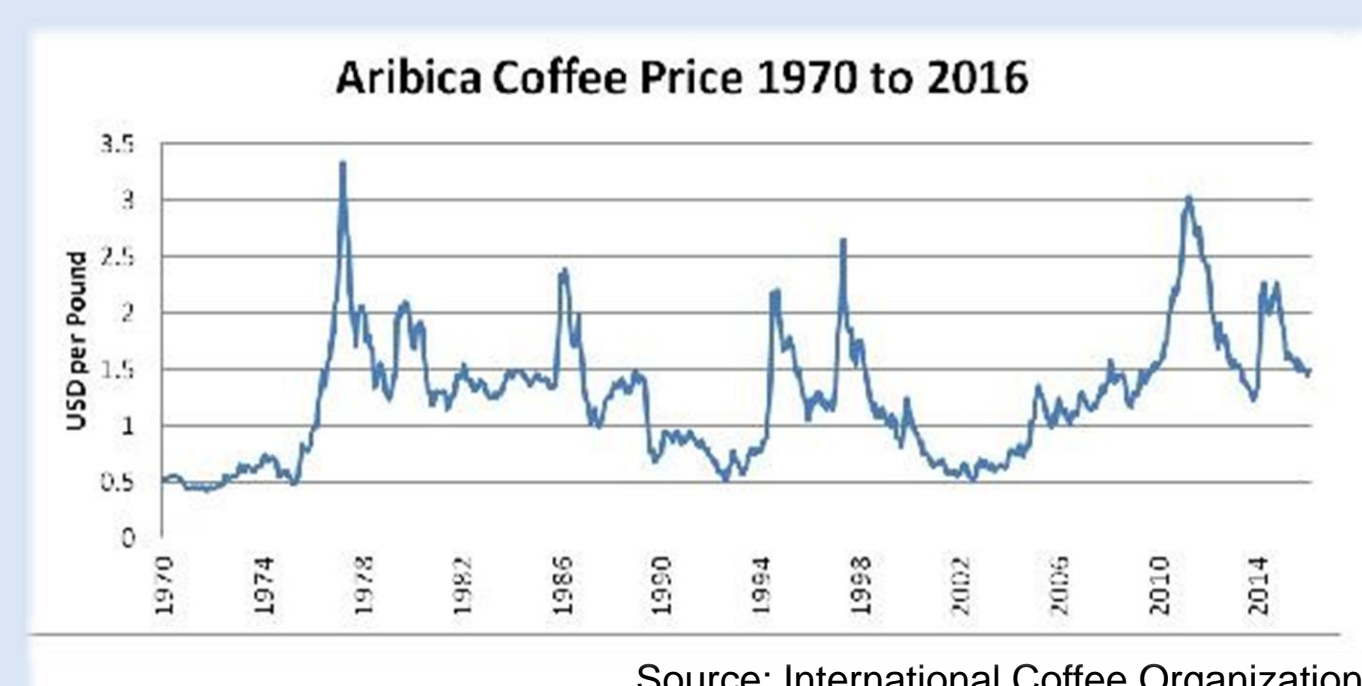
Soil health (SH) can be a prime determinant of agricultural productivity and economic welfare in coffee production. Since sustainability may offer a marketing advantage and significant price premiums, the ability for farmers to manage for soil health is crucial.

FTP Contract Prices and the ICO Price
Source: Transparenttradecoffee.org

However, farmers' ability to accurately perceive and qualitatively assess their SH given the resource and financial constraints of soil testing in rural Colombia can be useful to farmers in ensuring access to these price premiums.
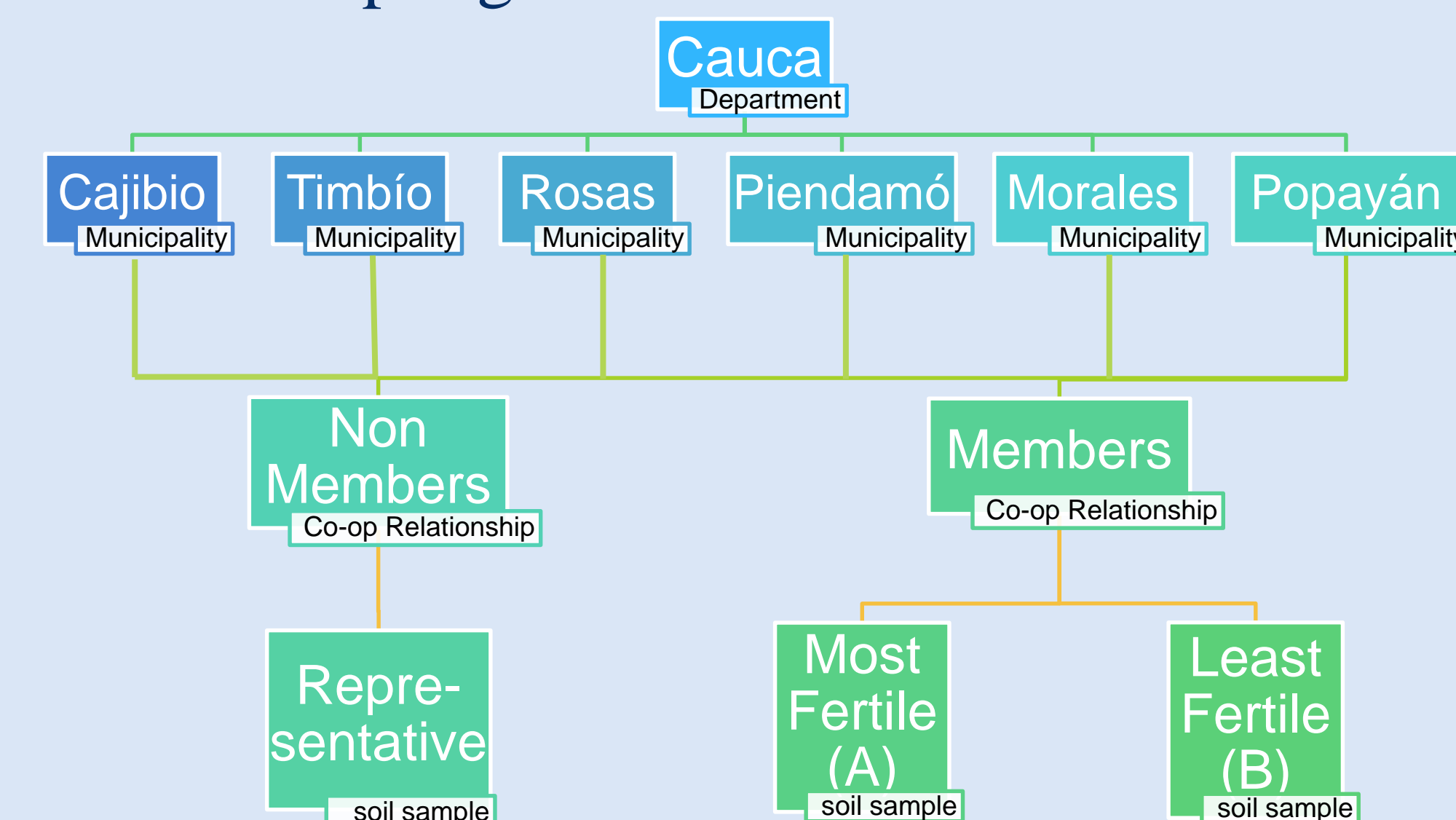
Objectives

To identify:
- whether coffee farmers have accurate perceptions of soil health;
- the demographic and environmental factors that play a role in farmers' perception of soil health and its accuracy;
- soil health indicators most associated with farmers' perceptions.

Methods

- Project Location

Legend
- Colombia
- Cauca

Municipalities
- Cajibio
- Morales
- Piendamó
- Popayán
- Rosas
- Timbio
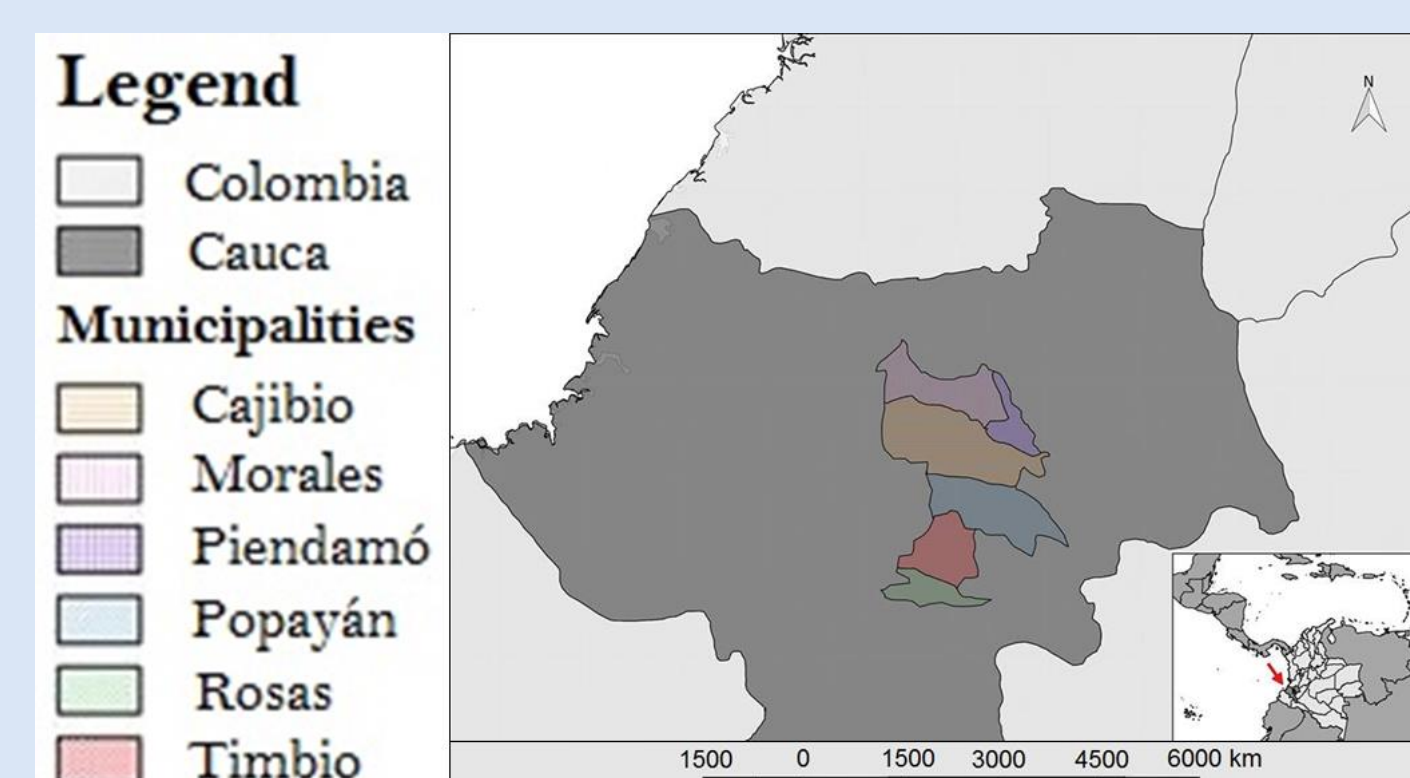
- Soil Sampling

- Laboratory Measurements:

Wet aggregate stability (WAS), available water capacity (AWC), active carbon (AC), organic matter (OM), protein, respiration, pH, phosphorus (P), potassium (K), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn).

- Soil Health Scoring:

We compared the laboratory measurements of each indicator to a standardized dataset using the Cumulative Normal Distribution (CND) which gives the probability that a member of the distribution is less or equal to the indicator measurement:

$$CND\ (x, \mu, \sigma) = \frac{1}{2}\left(1 + erf\left[\frac{(x-m)}{s\sqrt{2}}\right]\right) \times 100$$

x= SH indicator measurement $\mu \approx$ sample mean (m) $\sigma \approx$ sample stdev. (s)

- Statistical Analyses

ANOVA:
- factors influencing SH (gender, co-op membership)
- farmers' SH perception accuracy (is it accurate? inaccurate?)

Logistical Regression and PCA:
- SH indicators most affecting farmers' perceptions

Fisher's Exact Test for Count Data:
- factors influencing farmers' SH perception accuracy (gender, farms' true SH conditions)

Results

Soil Health is higher for female farmers and co-op members than for male farmers and non co-op members

Figure 1: Soil Health by Gender

Figure 3: Soil Health by co-op membership
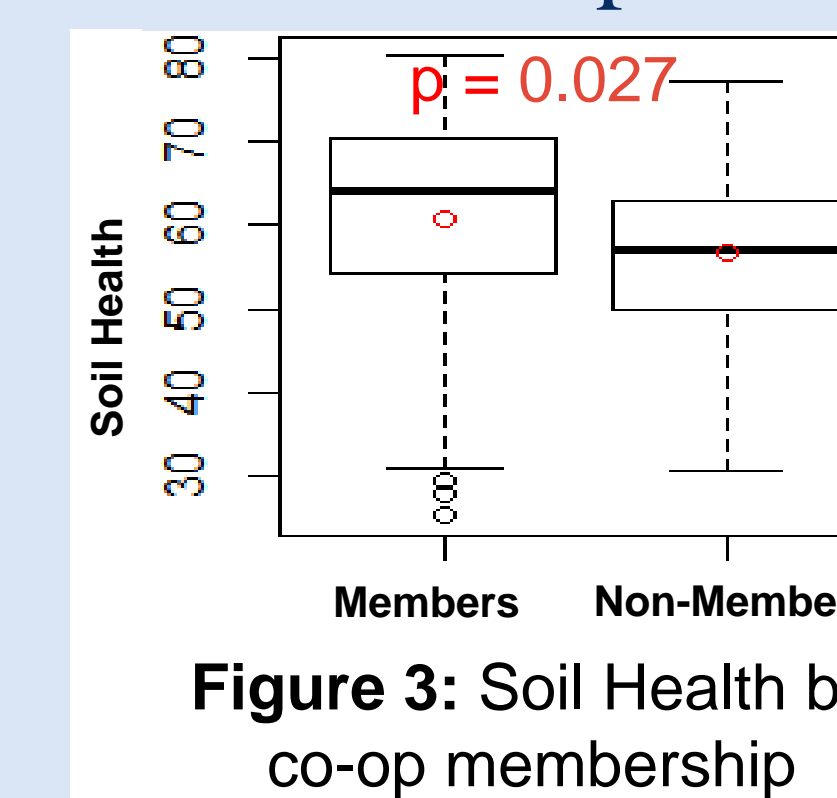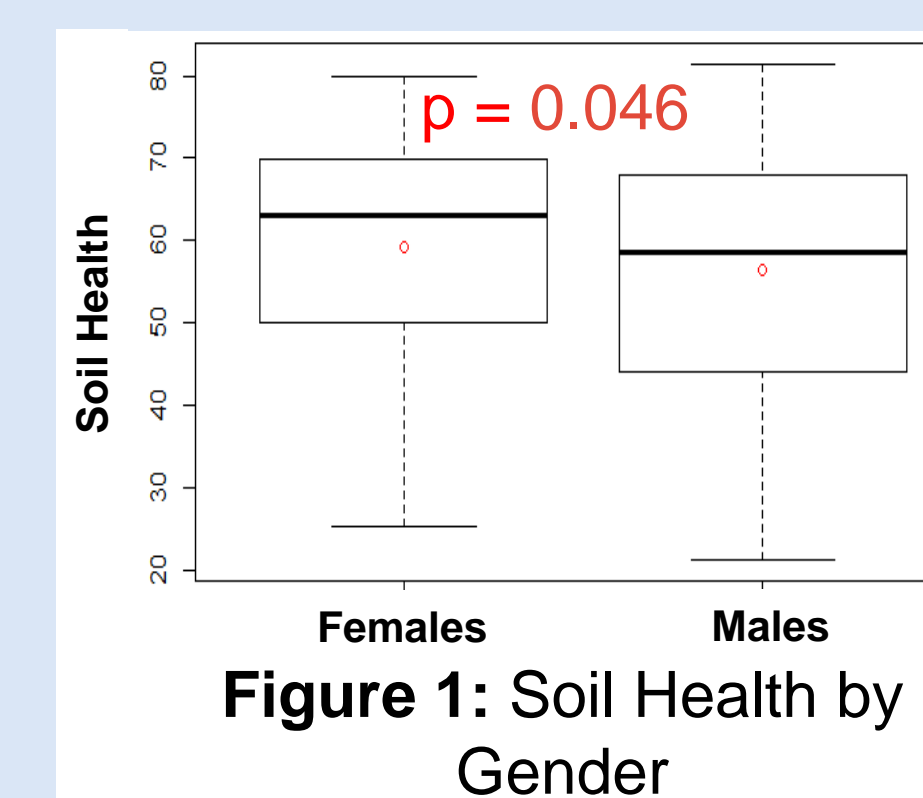
Biological indicators are key determinants of farmers' SH perceptions

Figure 4: Loadings of Two PC Dimensions of SH Indicators
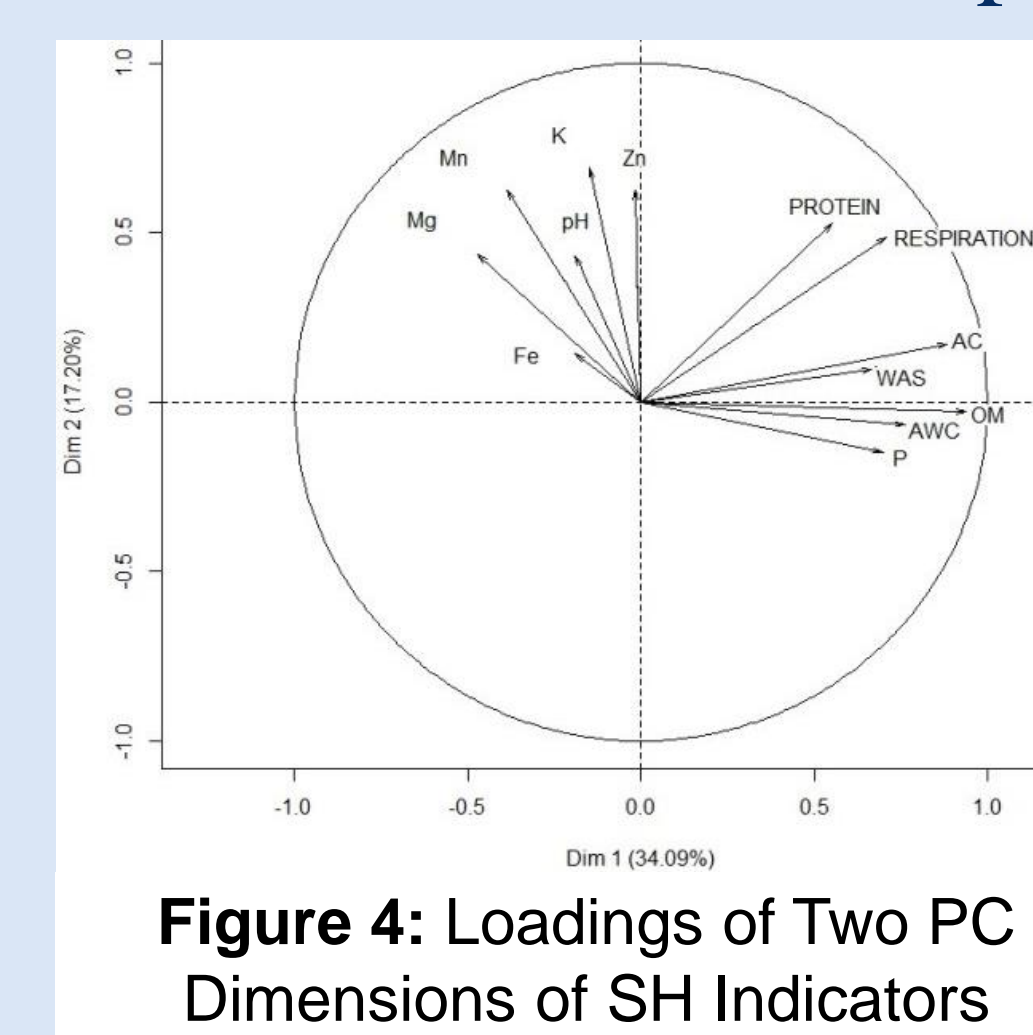
Table 2: SH Indicators that Influence Farmers' Perception

	Estimate	Pr(>|z|)
(Intercept)	-0.016464	0.92811
OM	1.539695	0.00324**
AC	-0.923761	0.07848.
AWC	-0.001368	0.99641
Respiration	-0.727225	0.02001*
P	-0.167848	0.51643
WAS	-0.239705	0.30385
Protein	1.256712	2.48e−05 ***

Soil health was higher for areas that farmers identified as most fertile

Figure 5: Soil health of groups "most fertile" and "least fertile"
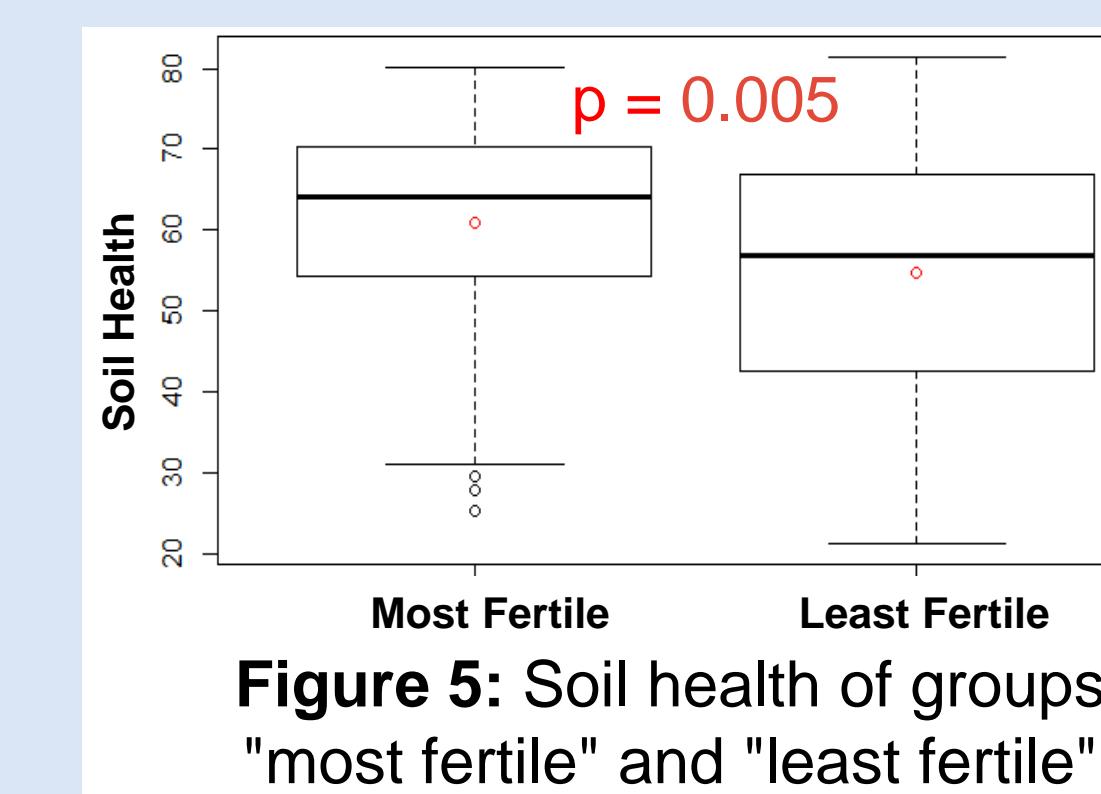
Farmers' perception accuracy is influenced by their land's actual SH conditions, but not by their gender
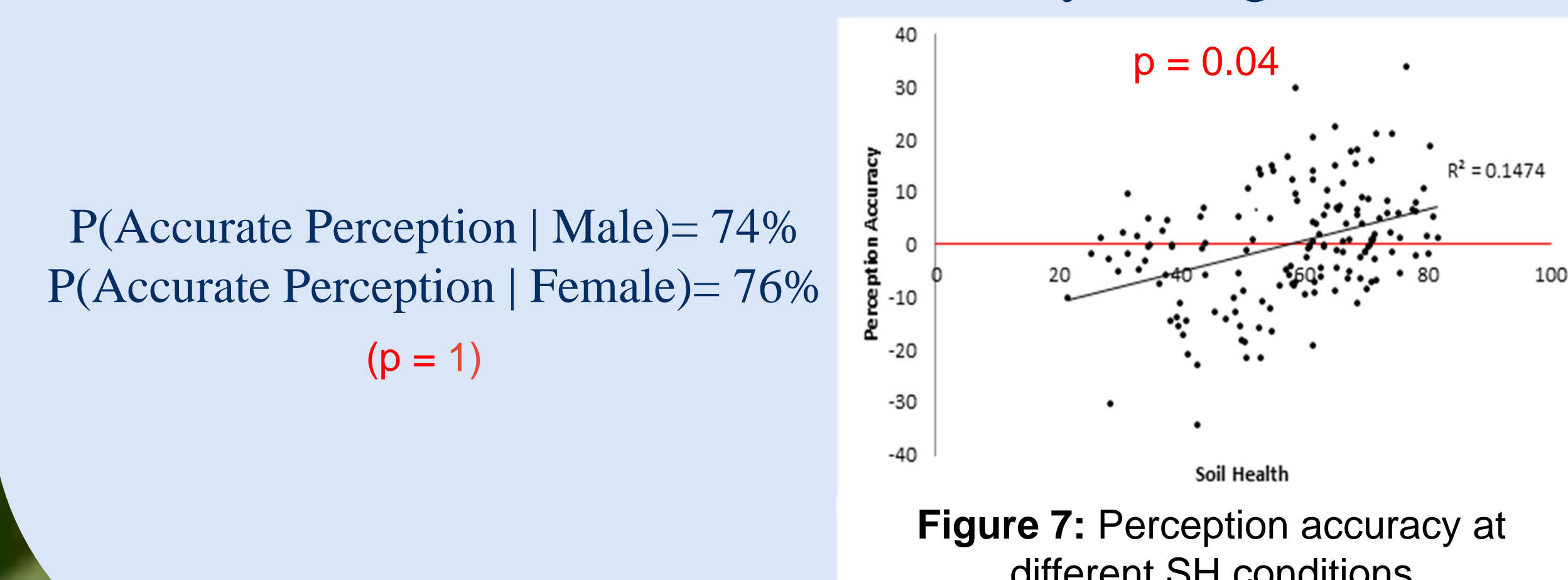
P(Accurate Perception | Male)= 74%
P(Accurate Perception | Female)= 76%
(p = 1)

Figure 7: Perception accuracy at different SH conditions

Conclusions

In assessing which factors influence soil health (SH) in Colombian coffee farms and farmers' perceptions thereof, we concluded that:
- female farmers and co-op members have significantly higher SH than their counterparts,
- farmers appear to have correct perception of their SH which is not associated with what their gender is, but with how healthy their soil actually is,
- Organic matter, respiration and protein are indicators that are most related to farmers' perceptions of their SH.

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