

# Agro-ecology determines farm typology effect on soil fertility variability in small-scale farmers of Ethiopia



UNIVERSITY OF HOHENHEIM

Birhanu Agumas Endalew<sup>a,b</sup>, Generose Nziguheba<sup>c</sup>, Georg Cadisch<sup>a</sup>, Frank Rasche<sup>a</sup>

<sup>a</sup>Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute), University of Hohenheim, 70593 Stuttgart, Germany.

<sup>b</sup>Amhara Regional Agricultural Research Institute (ARARI), PO Box 527, Bahir Dar, Ethiopia.

<sup>c</sup>International Institute for Tropical Agriculture (IITA), c/o ICIPE, PO Box 30772-00100, Nairobi, Kenya.

## Introduction and objectives

Agro-ecology, farm typology and indigenous knowledge influence farmers' decisions on integrated soil fertility management (ISFM). Consideration of those combined effects and investigations of the relative importance of each factor in soil fertility variability may provide guidelines to the development of site-specific ISFM strategies. One step towards this aim is the development of harmonized soil fertility survey tools applicable to diverse socio-ecological contexts, with emphasis on agro-ecology and farm typology. The objectives of this study were (1) to develop for two regions in Central and Western Ethiopia generic partial least square regression (PLSR)-based prediction models for selected soil fertility indicators, and (2) to illustrate the interrelated effect of agro-ecology and resources endowment of farmers on soil fertility status of small-scale farmers of Central and Western Ethiopia.

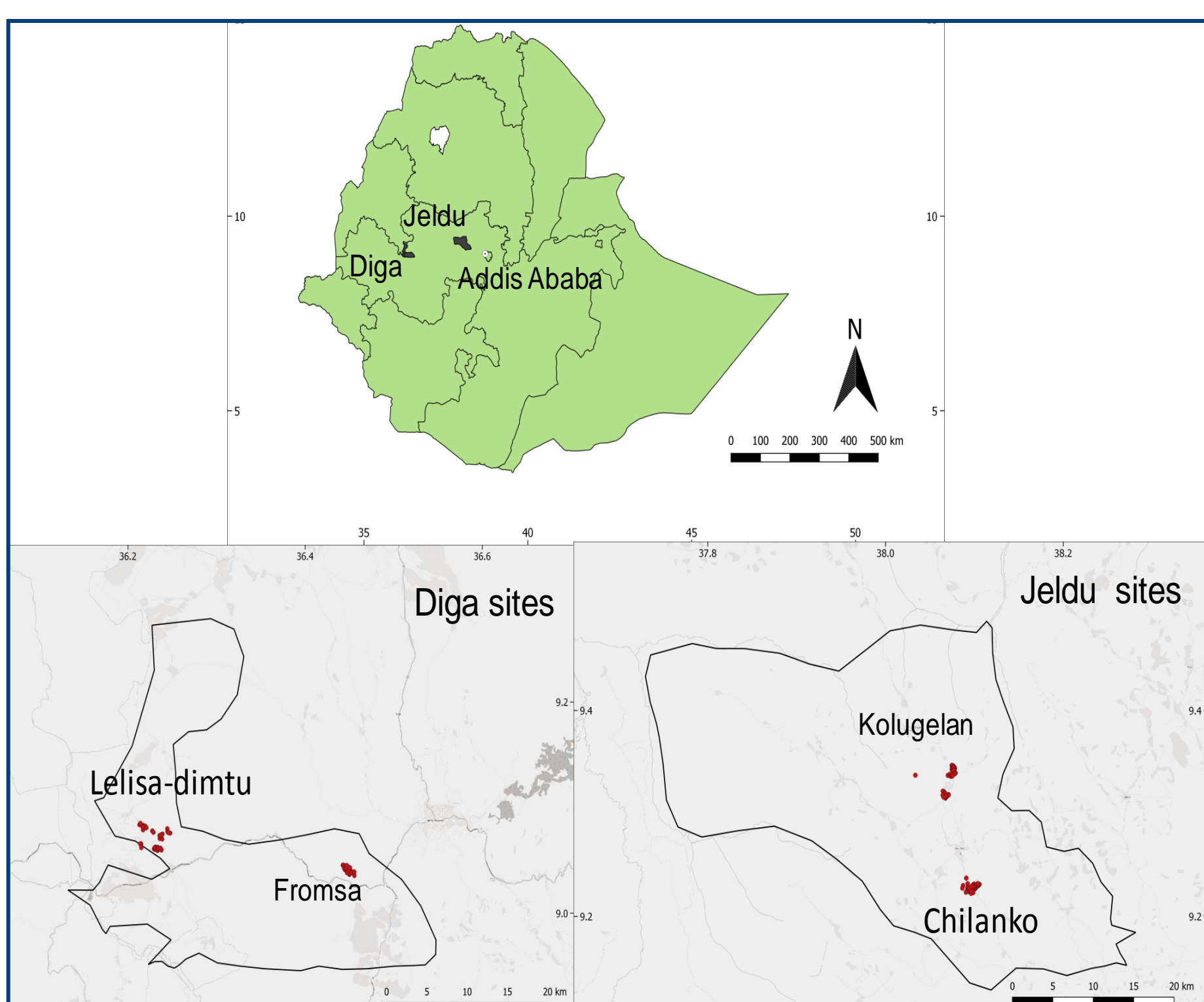
## Materials and methods

The study was conducted in Central (Kolugelan (KG) and Chilanko (CH) in Jeldu district) and Western (Lelisadimtu (LD) and Fromsa (FR) in Diga district) Ethiopia representing different agro-ecologies (Table 1 & Fig. 1).

**Table 1. Description of the agro-ecology (sites) of the study regions in Central and Western Ethiopia**

Site characteristics	LD	FR	CH	KG
Ago-ecology	Kolla	WD	HD	Dega
Average elevation (m.a.s.l)	1281	2177	2911	2784
Mean annual rainfall (mm)	2037	1376	938	938
Mean daily temperature (°C)	21	21	18	18
Major farm typologies	2	2	2	2

WD, Weina-dega; HD, High dega.



**Fig. 1. Study regions with sampling points located in Central (Dega, HD) and Western (Kola, WD) Ethiopia.**

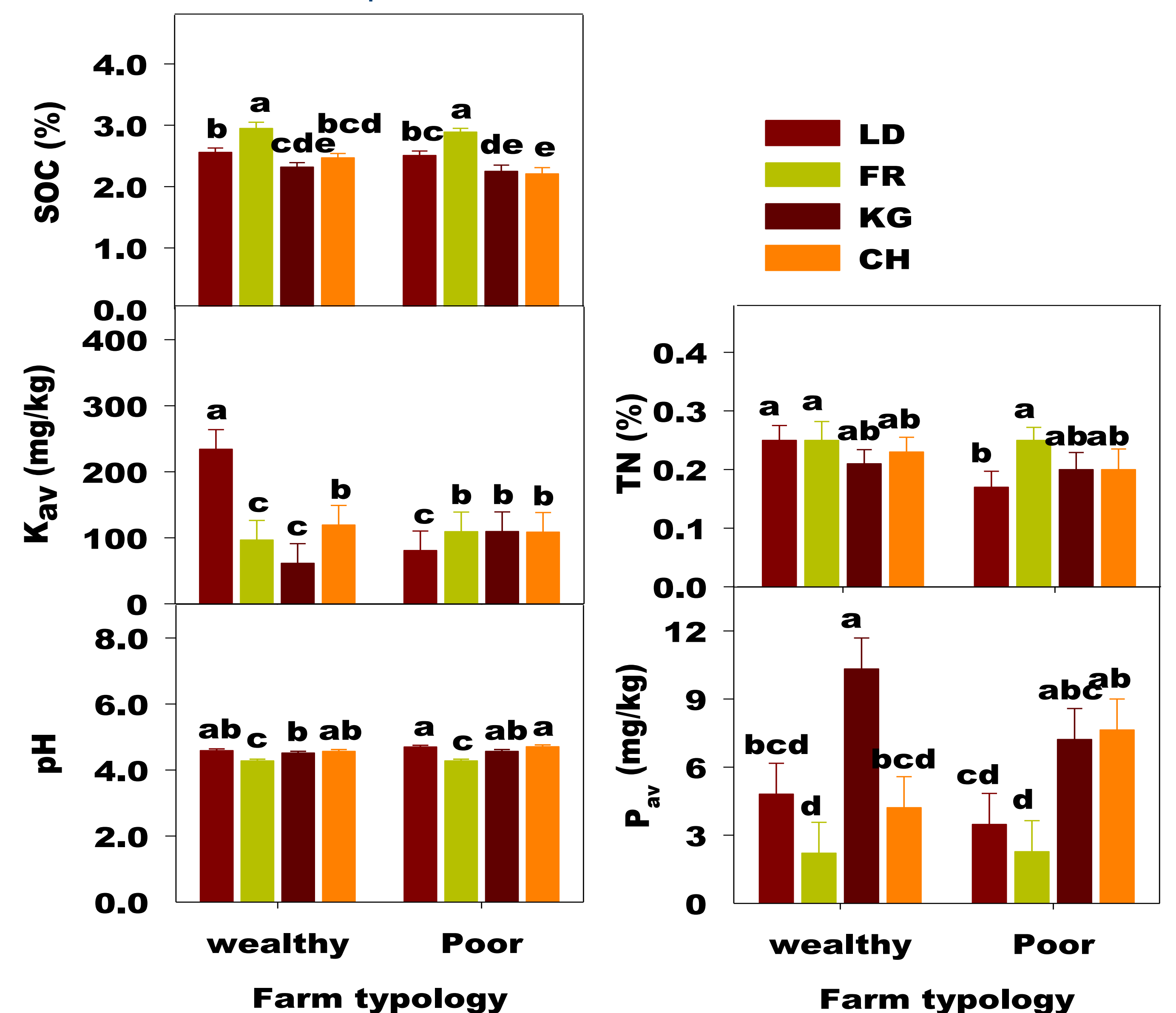
Forty-two percent of soil samples (n = 96) were analyzed using wet chemistry and used for prediction model development. All samples were subjected to mid-infrared spectroscopic analysis (miDRIFTS) (Rasche et al., 2013). MidDRIFTS-PLSR-based prediction models for each soil chemical property were constructed with the OPUS-QUANT2 package of OPUS version 7.5 (Rasche et al., 2013).

## Results and discussion

**Table 2. Calibration results of midDRIFTS spectra of bulk soils across study sites, based on Cross validation (n = 96).**

Soil properties	Measured	Predicted	Model accuracy parameters		
			R <sup>2</sup>	RPD	RMSECV
pH	4.48	4.50	0.84	3.1	2.52
OC (%)	2.41	2.52	0.90	3.1	0.20
TN(%)	0.20	0.21	0.86	2.7	0.02
P <sub>av</sub>	5.27	9.91	0.71	1.9	1.35
K <sub>av</sub>	186.2	169.4	0.36	1.3	242

R<sup>2</sup>; coefficient of determination, RPD; residual prediction deviation, RMSECV; root mean square error of cross validation



**Fig. 2. Selected soil chemical properties in wealthy and poor farmers' fields across agro ecologies**

➤ Total carbon (TC) content in soils was predicted accurately, whereas prediction of total nitrogen (TN) and pH was acceptable.

➤ Prediction of available phosphorous (P<sub>av</sub>) and potassium (K<sub>av</sub>) were not successful.

➤ Not only farmers' resource endowment, but also agro-ecology exposed a significant effect on soil chemical properties.

➤ This is explained with farmers' management decisions which varied due to wealth status and agro-ecology.

## Conclusions

The inter-related effect of agro-ecology and farm typology was a stronger determinant of soil fertility variability in the studied farming systems than the individual factors. Therefore, explicit site-specific soil fertility management strategies shall be developed for wealthy and poor small-scale farmers in Ethiopia.